GIS within an all-relational framework

Jennifer Cadkin ESRI- Technical Marketing

Ernie Ott ESRI-Transportation Marketing

GIS-T April 9-11, 2001

Back in the day...

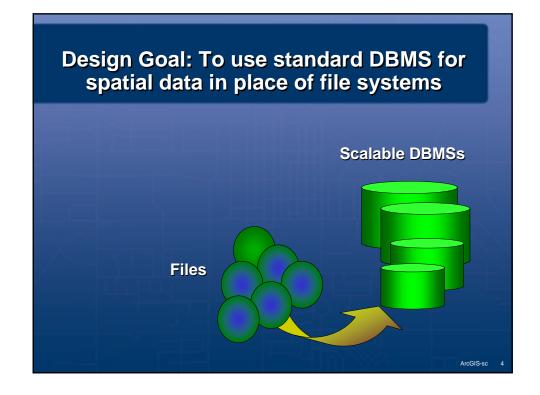
- When God created the earth:
 - After He rested on the 7th day...
 - He created the computer
 - Which was good
 - But He saw the computer was alone
 - Which was not so good
 - So He put the computer into stand-by mode, took from it a RIB, and made from it data (RIB: reusable instruction byte)
 - After this, the man and the woman, and all their children for many generations to come flocked to see the data, and the computer was never alone again.

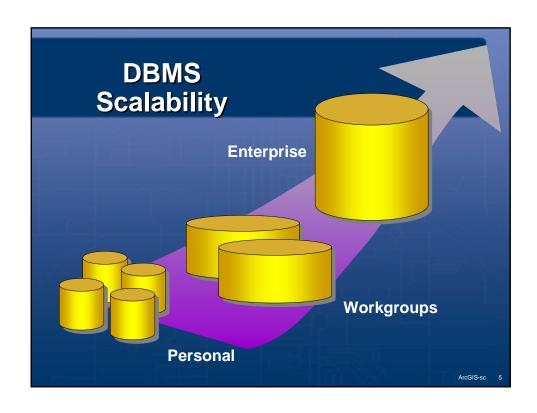
rcGIS-sc

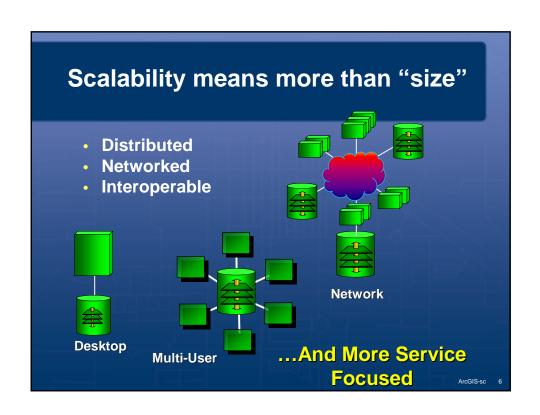
Why a database?

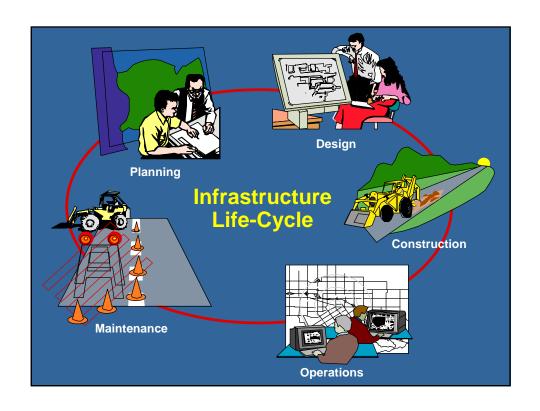
- Organizations need:
 - One file -- not a bunch of files
 - More flexible to use
 - Easier to manage
 - Secure, but accessible
 - Scalable
 - Persists across use and time

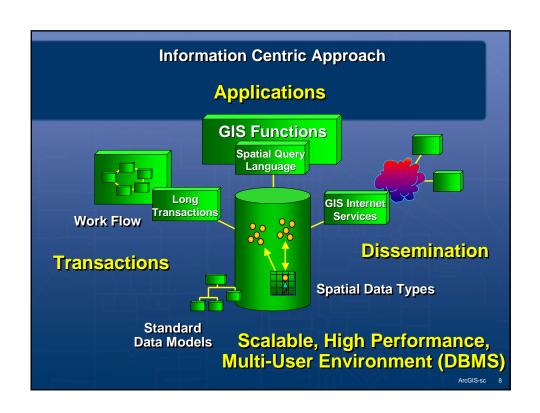
ArcGIS-sc



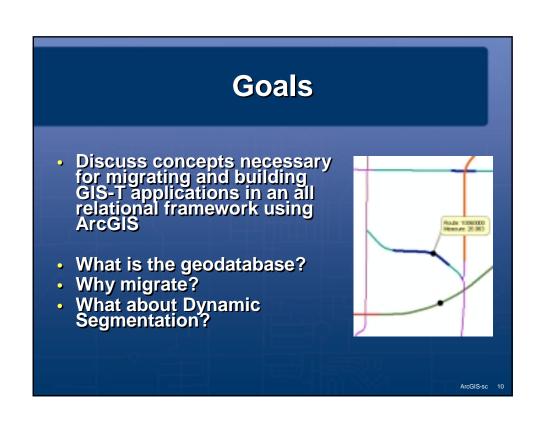












Why store GIS data in an RDBMS

- GIS users want better data management
 - data integrity
 - fast access for many simultaneous users
 - efficient use of the network
 - common environment to manage spatial and tabular data
 - SQL standard

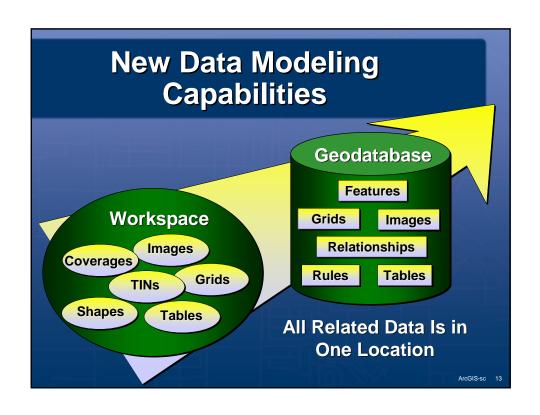
Why store GIS data in an RDBMS

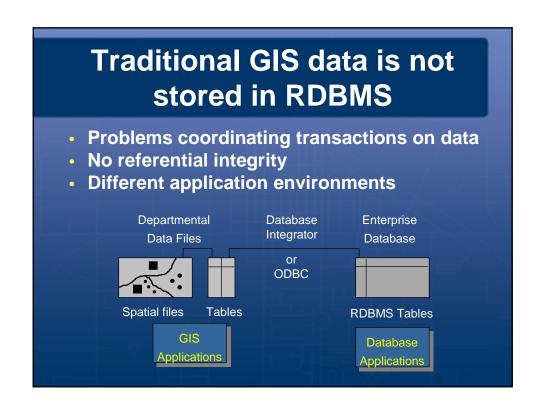
- MIS users want spatial functionality
 - Include spatial data as a managed enterprise asset
 - Support GIS applications
 - Spatially enable applications

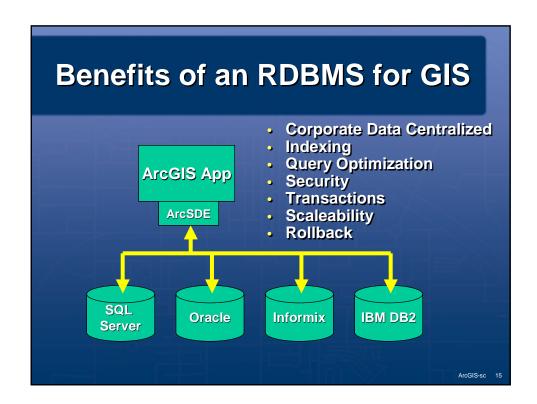
Example:

- Query to determine bus route and fare
- Operator types in to/from address
- Searches for route
- A rate appears on screen
- The operator never sees a map

GIS-sc 12



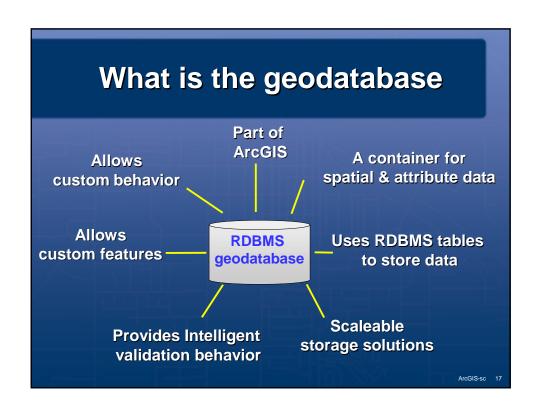


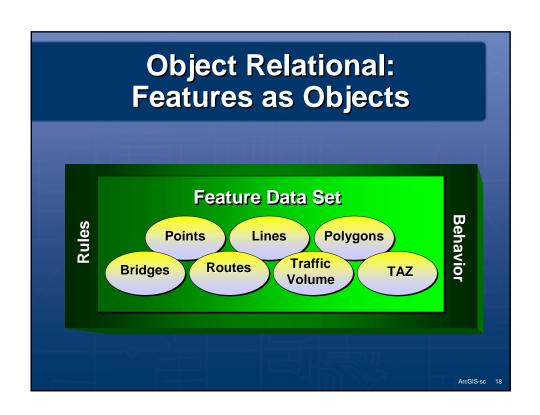


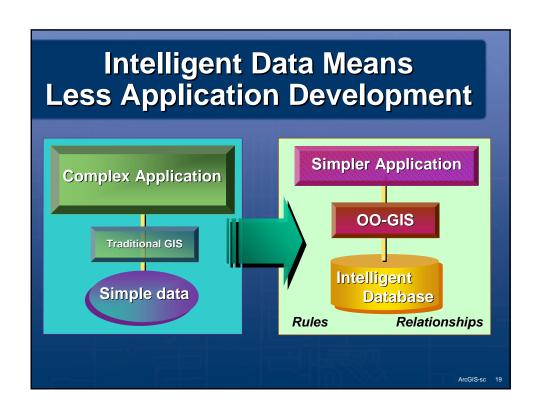
What is the geodatabase

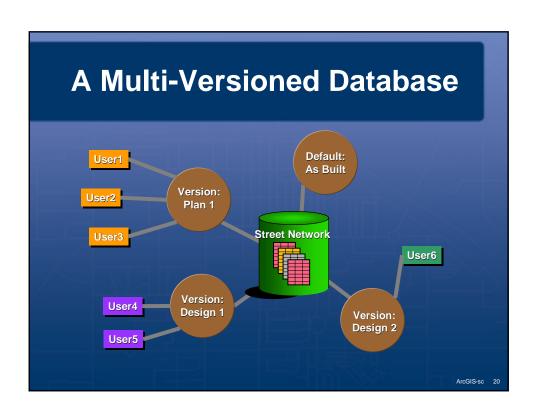
- A new geographic data model
- All relational data storage
- Features with behavior
 - Speed Limit coded value domains
- Topological relationships
 - Geometric Network
- Business Objects
 - Locator, Geoprocessor

rcGIS-sc 1









Database Design

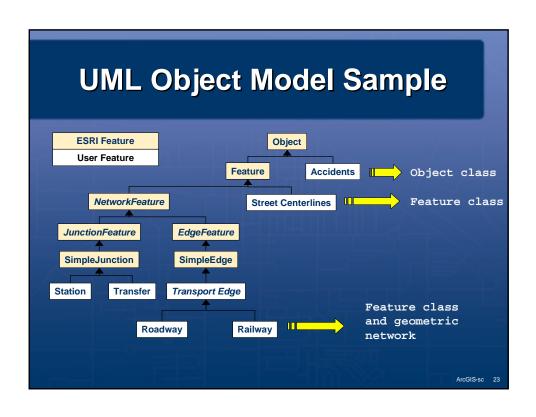
- Import spatial, tabular, raster and CAD data and/or
- Refine and extend existing classes; define new classes, or
- Use CASE and UML for a ground-up redesign of large system

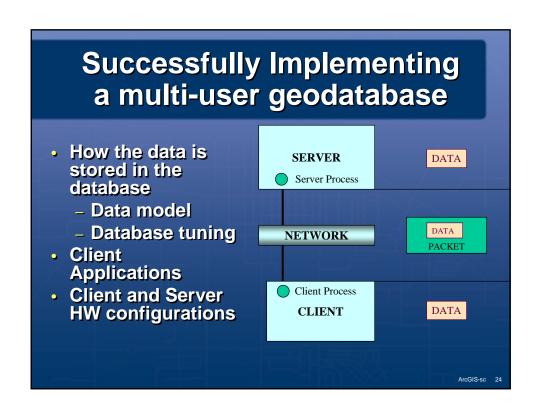
ArcGIS-sc :

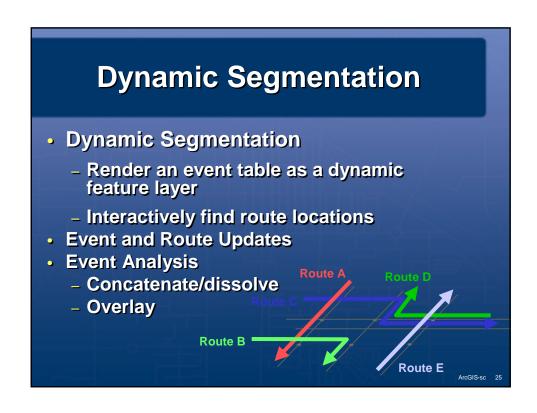
The UML/Case Tools Approach

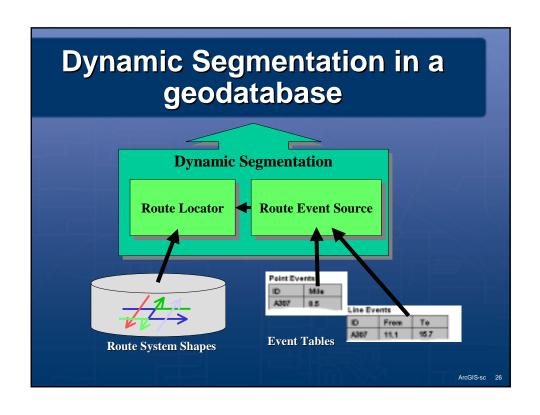
- Use UML to specify
 - Object, feature, and relationship classes
 - class properties, methods, subtypes
 - relationship and connectivity rules
- Use a CASE tool to capture your UML model.

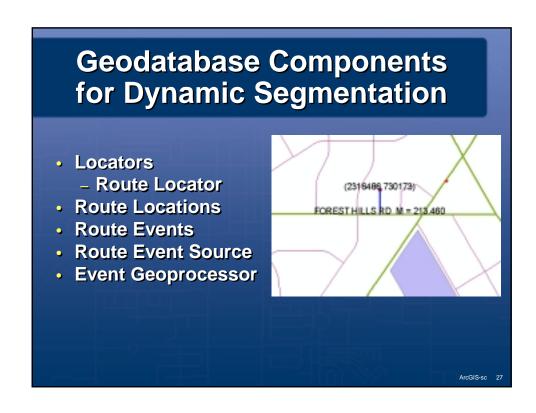
ArcGIS-sc 2

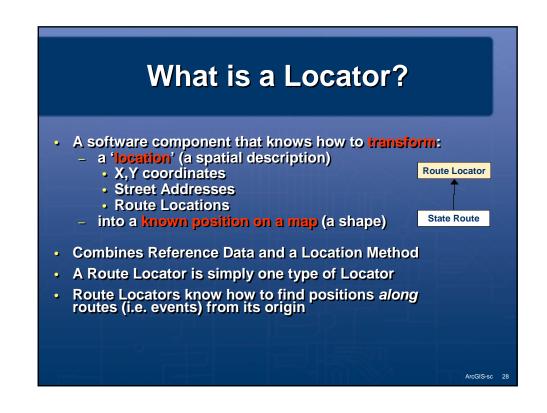


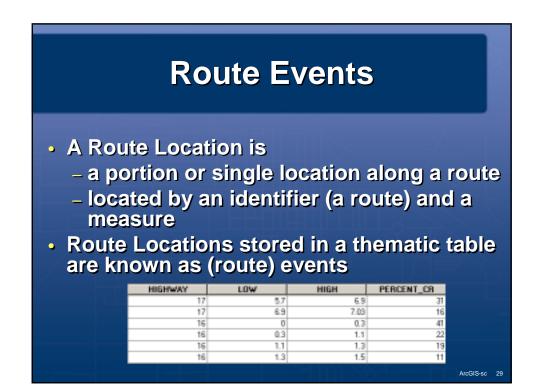


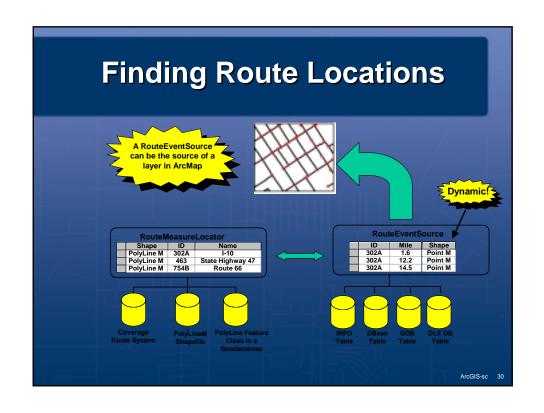












Summary: Why the geodatabase

- Stored in a RDBMS
- Multi-user editing w/ versions and long transactions
- Object oriented geographic data modeling using UML and case tools
- Features with behavior
- Relationships
- Topological relationships
- A set of 'objects' and ' rules' for GIS-T
 - Locators, Event Geoprocessor

ArcGIS-sc 3



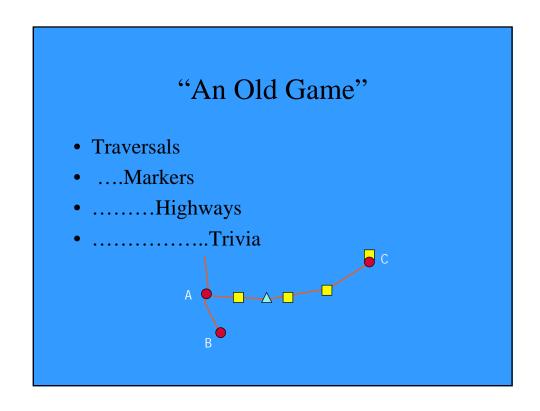
The Case for a Transportation/Highway Data Object Schema

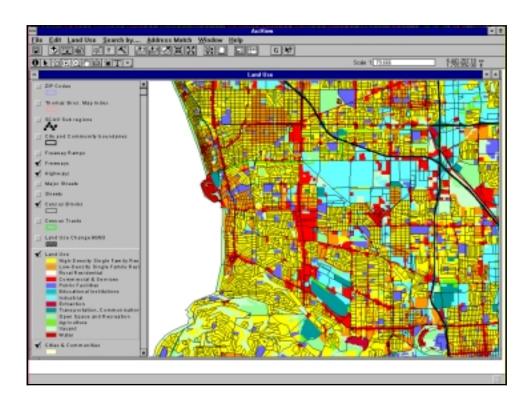
- "The dot on Line Problem "-

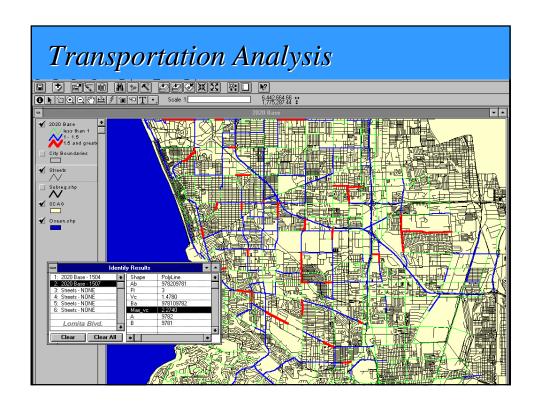
Simon Lewis GIST/Man, Inc. AASHTO GIS-T Symposium. Arlington, VA April 9-11, 2001

Overview

- History of transportation spatial activities
- What heard at conference
- Worry that we are on "the right road"
- Needs for a re-emphasis?
- Suggested a GIS-T practitioner's way forward?







The Problem

- "The Dot on a line problem"
- GIS has always done "polygon on polygon" overlay
- We have never been able to do (practically)"Point-on-Point overlay"
 - "Network overlay"

"Dot on line problem"

- We have not "solved this problem" until we have (reasonably) solved a pathway from "A to Z"
- Should DOT's be investing in parts of the solution until they have?

What Has Happened in GIS-T?

- Data
- Numbering
- Models
- Technology

What we Know: Data

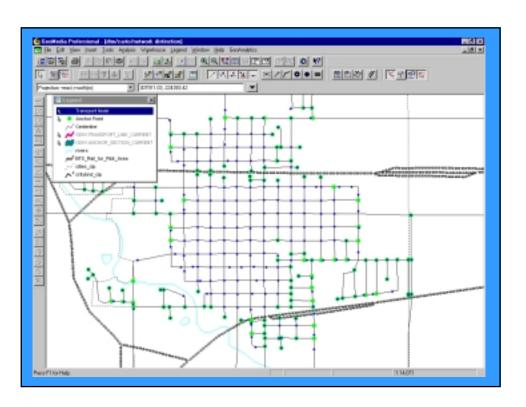
- The most expensive investment for an organization
- Created by many different organizations
- To solve many different problems
- Using many different methods and technologies

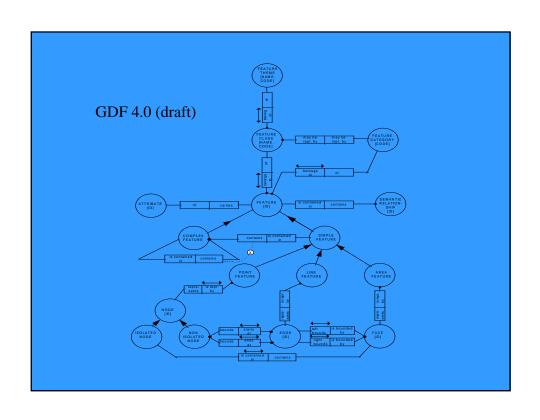
NSDI

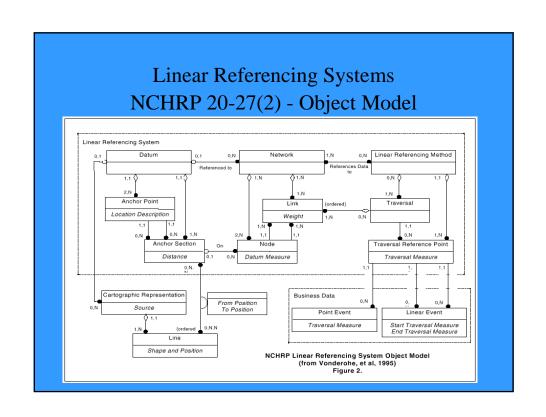


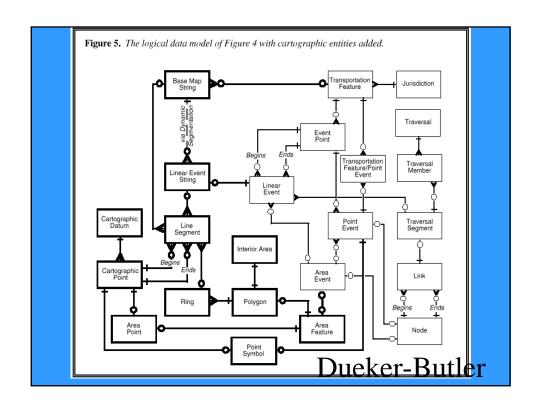
What have We Done: Focus on Models

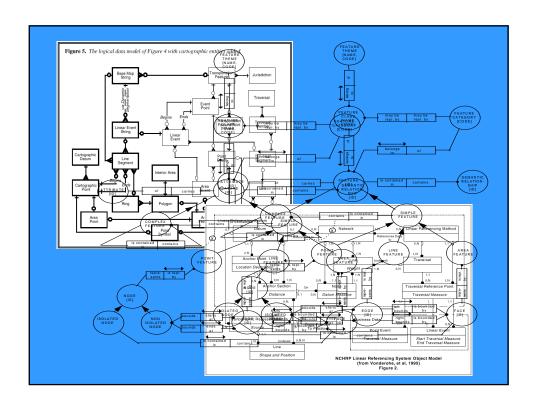
- TIGER
- FGDC
- NCHRP
- Dueker-Butler
- GDF 4.0 and XGDF
- ITS schema
- etc





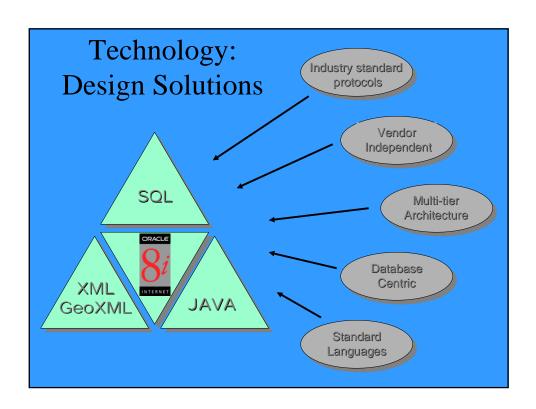


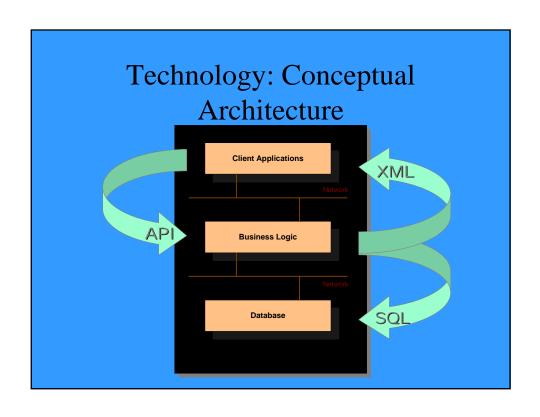


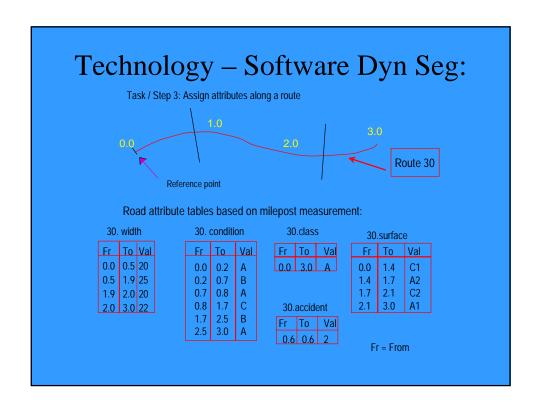


Key Issues in Road Data Models

- How do we 'chunk up' the infrastructure?
- Does everyone need to use the same *chunks*? How are they identified?
- What is the least amount of work necessary to document the chunks?
- Who does this work?







Technology: Software

- Software is being componentized and objectized
- Toolbox approach

!! STEP BACK !!

What do DOT's really need?

K.I.S.S.

What do DOT's Really Need?

- Simplicity
- Straightforwardness
- Lack of confusion
- Ideally solutions that help that from collection to storage

Highway Forms

- Highway designers taught to implement a variety of highway forms
- Highway Design Manual, CalTrans Design Manual
- These forms may have many variations, but common features
- Reflected in some of the existing models (UNETRANS, GDF)

HIGHWAY FEATURES AND NETWORKS

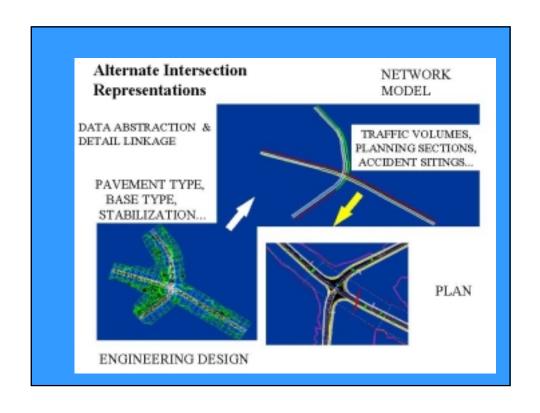
#	FEATURE	DESCRIPTION
1	Travelway	Portion of a roadway for the movement of vehicles, exclusive of shoulders
2	Divided Highway	A highway with separated roadbeds for traffic in opposing directions
3	Ramp	A connecting roadway between a freeway or expressway and another highway, road, or hillside area
4	Frontage	A local street or road auxiliary to and located on the side of the arterial highway
5	Tiered Roadways	Roads not art grade, or with multiple levels, such as a dual carriageway bi-directional bridge
6	One-way pairs)	Divided highway on one direction
7	Intersection	The general area where two or more roadways join or cross
8	Interchange	A system for inter-connecting roadways in conjunction with one or more grade separations
8	Rotaries	A traffic circle
9	Cul-de-sacs	A local street open at only one end only, with special provisions for turning around
10	Dead-End street	A local street open at only one end only, without special provisions for turning around

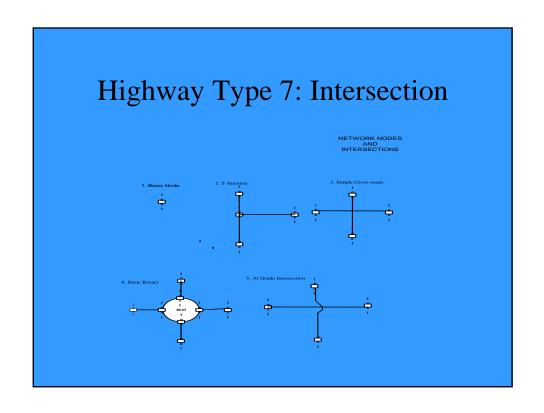
Transportation "Lego" TM

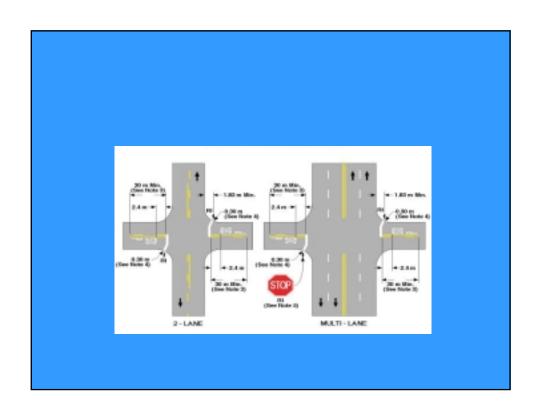
- Better described as a "Transportation Brio TM" as linear
- Modular, building blocks
- Interconnecting linear track pieces
- Set of logical data a management units
- Repeatable logic

Pre-coded Transportation Network Objects

- 1. Geometry: I.e., I have width, height, scaqle characteristics, <u>Draw</u> at various scales, say 1:100,00 → .1:200
- **2. Topology:** e.g., "Connect cloverleaf, Type 7.5, subtype C, to a *dual lane highway*, Type 2.3, sub-type E
- **3.** Transportation Attribute: Characteristics lane width, type →80 Characteristics
- **4. LRS trace:** through a cul-de-sac







Transportation "Lego" TM: Outline Form 1

- 1. Anchor Reference Points: bound
- 2. Control Section Form: similar
- 3. Local Linear Reference
- 4. Topology
- 5. Geometry

Transportation "Lego" TM: Outline Form 2

- 6. Display Form
- 7. Linear Path Trace
- 8. Attribute Data
- 9. Universal Operators
- 10. Generalizability and Substitutability

Key Tasks: Transportation "Lego" TM

- Creation: How to partition the network
- *Maintenance:* How deal with geometric update
- *Use:* How to represent the Transportation Lego

Transportation "Lego" TM: Data Form Creation 1

Data Porm Cication 1

- 1. Maintenance of Current Practices
- 2. Inventory of Current Parts
- 3. Basic Toolkit Selection
- 4. Toolkit Mapping
- 5. Creation of Classes of Anchor Reference Points

Transportation "Lego" TM:

Data Form Creation 2

- 6. Network Segmentation
- 7. Assignment of Geometries
- 8. Accuracy Measures
- 9. Automated Network Checking
- 10. Manual checks

Transportation "Lego" TM:

Maintenance 1

- **1. Geometric Update:** Basic Update check: As new information is added, encoded checking
- **2. Mapping Forms:** Add through defined templates
- 3. Route calibration:
 - 1. As is
 - 2. Within transportation lego unit
 - 3. Route level update

Transportation "Lego" TM: Maintenance 2

- Topological Update
 - Connections maintained
 - Centerlines meet
- Attribute Update

Benefits of the Approach 1

- 1. LRS Facilitation
- 2. Recycle Logic
- 3. Standardization
- 4. Time stamping
- 5. Implementation support

Benefits of the Approach 2

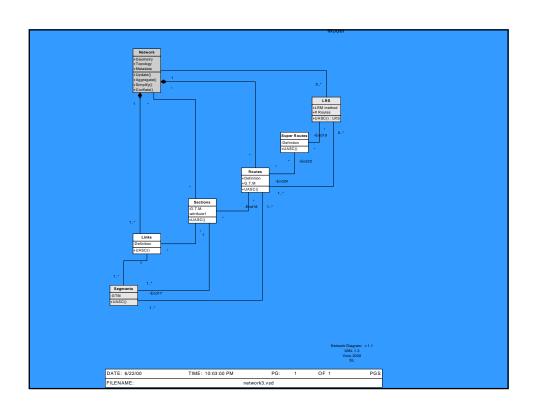
- 6. Interoperability
- 7. Reuse of data structures
- 8. Meta data
- 9. OO Methods
- 10. COTS Support

"Middle Out" Strategy

- Compromise between setting up and maintaining the spatial characteristics of networks
 - *Single-line* representations
 - Complex Engineering-level Detailed representations

Potential Weakness of the Approach

- Implementation cost
 - Institutional set-up
- Technical Issues
 - Conversion of existing networks
- COTS Support
 - Need vendor adoption
- Need for Further Field Testing
 - Pilots needed

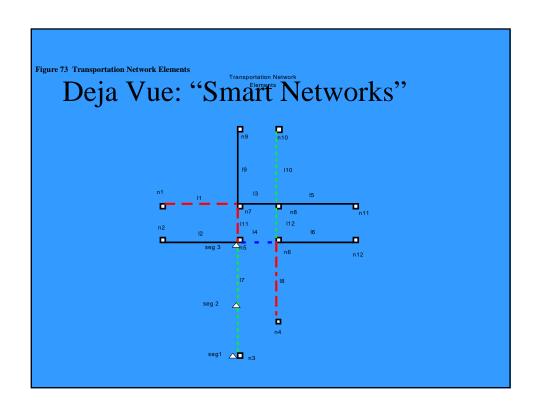


Final Conclusions 1

- More "data centric" approaches proposed
- A library of data management parts proposed
- Point, line, polygon AND transportation network parts

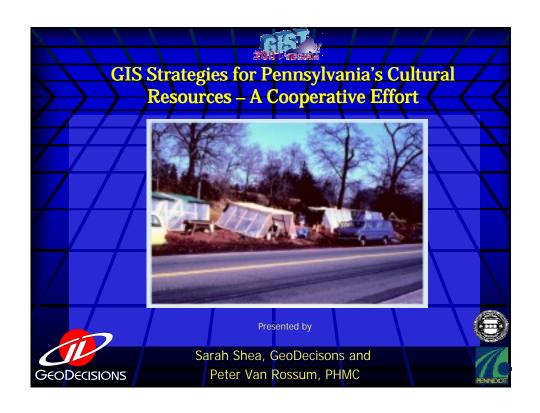
Final Conclusions 2

- Idea does go more "A to Z" (field capture to storage)
- Would best need national creation and support
- Toolbox approach for both software and data
- Completed in the in public interest



Transportation Linear Referencing Toolboxes: A Reflective Practitioner's Design Approach

Simon Lewis. MIT. Sept 2000

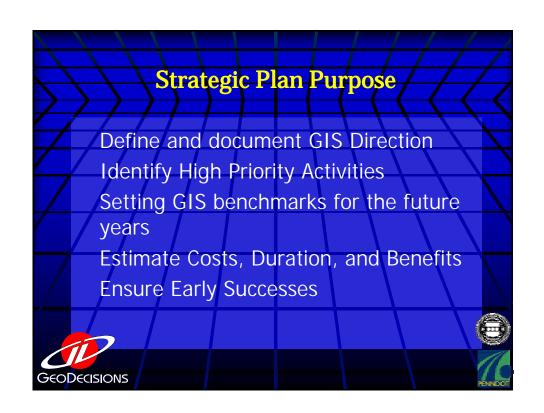














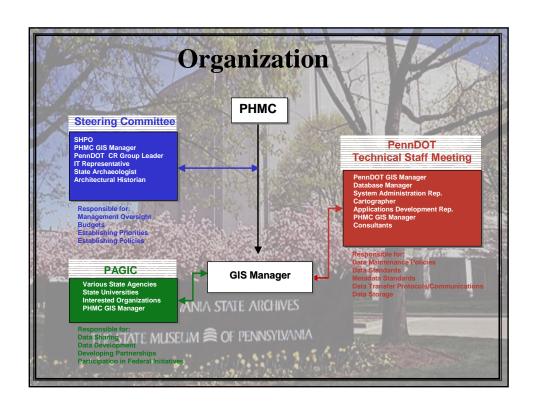


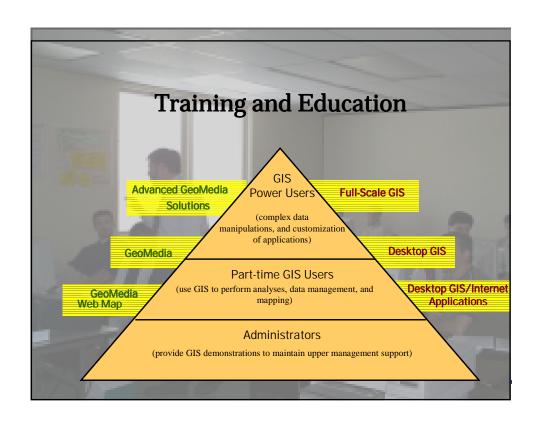


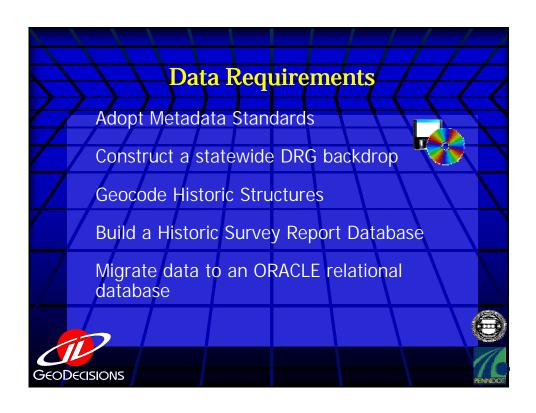


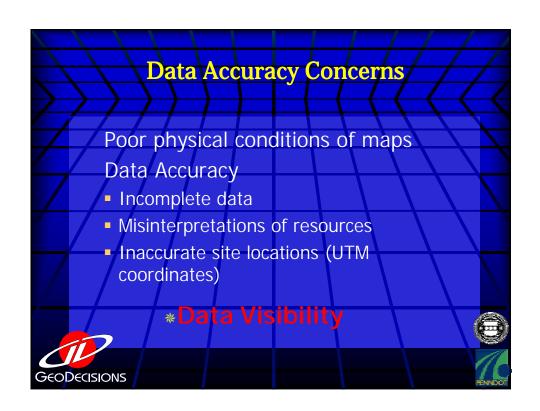






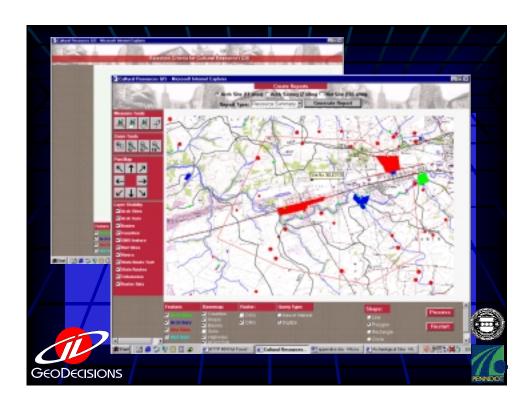


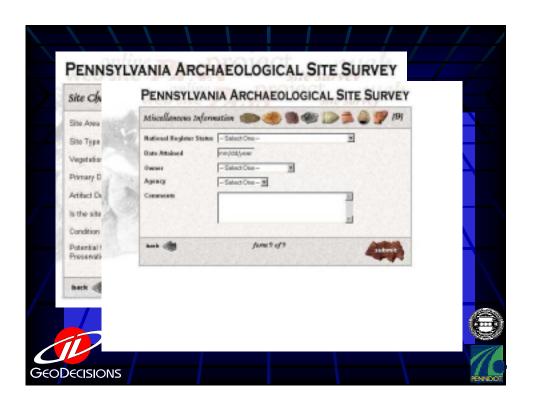




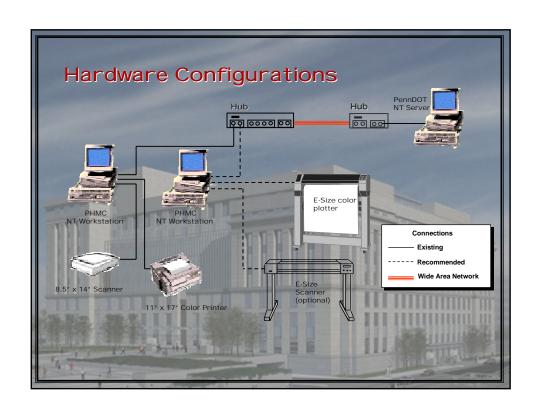




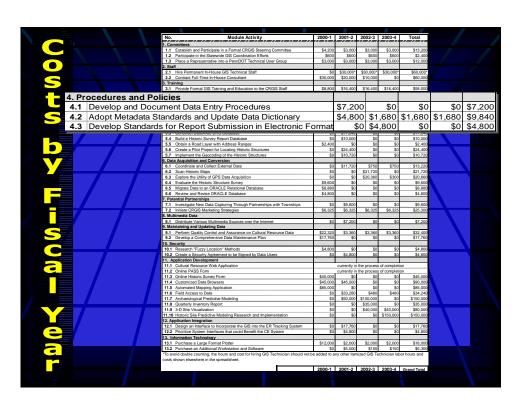


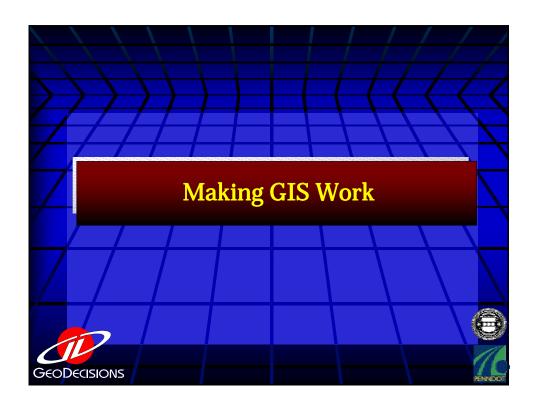


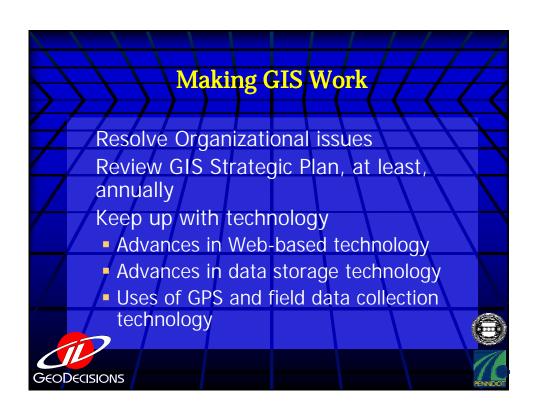


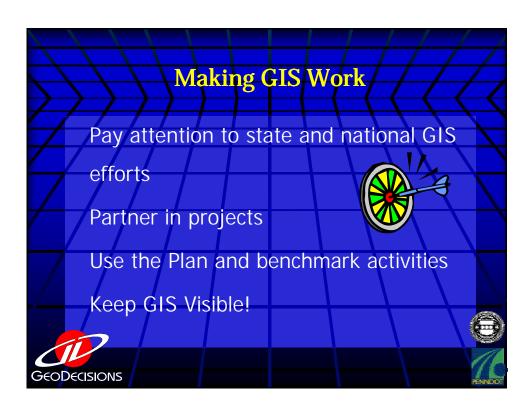


			Fiscal Year	Year 1		ear 2	Year 3		Year 4		
			Year	2000	2001		002	2003	2004		
		No. Module Activity	Quarter	3 4 1	2 3	4 1 2	3 4 1	2 3	4 1 2		
		1. Committees									
		1.1 Establish and Participate in a Formal CRGIS Steering Committee						_			
		Participate in the Statewide GIS Coordination Efforts Place a Representative into a PennDOT Technical User Group		-	-		-	_			
		2. Staff						_			
		2.1 Hire Permanent In-House GIS Technical Staff									
		2.2 Contract Full-Time In-House Consultant		1 1	_			Ц_			
		es and Policies									
	4.1 Develo	p and Document Data Entry Procedure	es					į			
e	4.2 Adopt	Metadata Standards and Update Data	Dictionary								
	4.3 Develo	p Standards for Report Submission in	Flectronic	Forma	at						
	207010		000.110	. 0						_	
		5.4 Build a Historic Survey Report Database						_	1		
		5.5 Obtain a Road Layer with Address Ranges									
		5.6 Create a Pilot Project for Locating Historic Structures									
<u>e</u>	7	5.7 Implement the Geocoding of the Historic Structures									
		6. Data Acquisition and Conversion						_			
	/ /	6.1 Coordinate and Collect External Data						_			
		Scan Historic Maps Explore the Utility of GPS Data Acquisition			-	-		_			
		6.4 Evaluate the Historic Structure Survey				_		_			
		6.5 Migrate Data to an ORACLE Relational Database			-		-	_			
		6.6 Review and Revise ORACLE Database			_	_		_			
		7. Potential Partnerships						_			
		7.1 Investigate New Data Capturing Through Partnerships with Townshi	ns		\neg	_		_		A	
		7.2 Initiate CRGIS Marketing Strategies									
		8. Multimedia Data									
		8.1 Distribute Various Multimedia Sources over the Internet		1.1		1		_			
		9. Maintaining and Updating Data									
		9.1 Perform Quality Control and Assurance on Cultural Resource Data		1.1		1			1 1		
		9.2 Develop a Comprehensive Data Maintenance Plan									
		10. Security									
		10.1 Research "Fuzzy Location" Methods									
		10.2 Create a Security Agreement to be Signed by Data Users									
		11. Application Development									
		11.1 Cultural Resource Web Application			_	-1	-	_			
		11.2 Online PASS Form			-	_		_			
		11.3 Online Historic Survey Form 11.4 Customized Data Browsers				-	-	_			
		11.5 Automated Mapping Application				_		_			
		11.6 Field Access to Data				1					
		11.7 Archaeological Predictive Modeling									
		11.8 Quarterly Inventory Report									
		11.9 3-D Site Visualization									
		11.10 Historic Site Predictive Modeling Research and Implementation									
		12. Application Integration									
		12.1 Design an Interface to Incorporate the GIS into the ER Tracking Sys	tem								
		12.2 Prioritize System Interfaces that could Benefit the CE System									
		13. Information Technology									
		13.1 Purchase a Large Format Plotter									
		13.2 Purchase an Additional Workstation and Software				1					













Canadian Ground Transportation Network Data Study PROJECT OVERVIEW

Presentation Made at the 2001 AASHTO GIS-T Conference April 11, 2001

David Loukes, P.Eng.

NGTN Project Results - CCOG Presentation

Geoplan

Thought for the Day ...

The Spatial Data Infrastructure paradox:

- 1. "When eating an elephant, take one bite at a time."
- 2. "You can't cross a chasm in two small leaps".

Authors Unknown

NGTN Project Results - CCOG Presentati

Background

- National Road Network Data Study sponsored by the National Ground Transportation Advisory Node (NGTAN) of GeoConnections
 - this is a high priority for the Canadian Geospatial Data Infrastructure (CGDI)
- Primary objective: develop data model recommendations and implementation strategies for an integrated national ground transportation network (NGTN) data layer for the CGDI

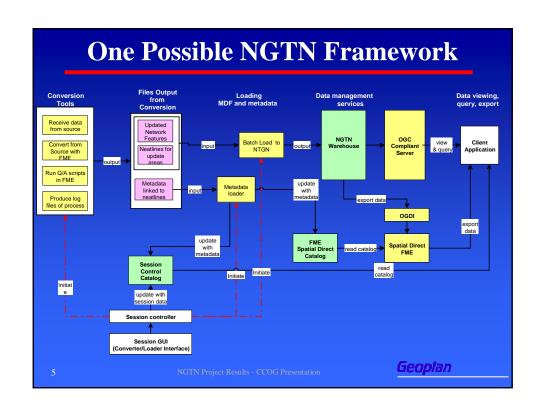
NGTN Project Results - CCOG Presentatio

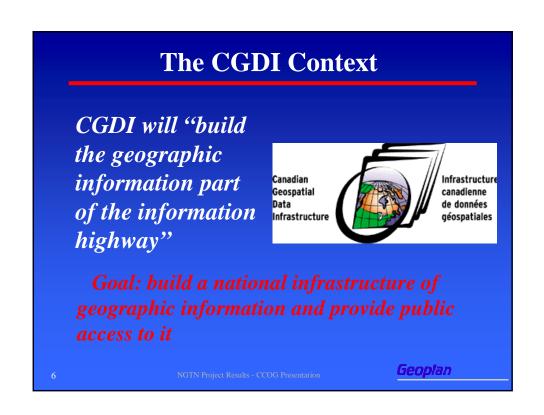
Geoplar.

The NGTN Vision

- A common spatial representation
- A core attribute data model and data dictionary
- Attribute linkage mechanisms
- A common Metadata model
- A phased implementation plan
- A distribution model for a "core" NGTN dataset that is free of IP restrictions and affordable

NGTN Project Results - CCOG Presentation







CGDI Framework Data

- Geographic Framework for Canada:
 - **simplify data integration**
 - basis for application development and valueadded products and services
 - framework on which other datasets can be built
- core set of data and more specific databases
- agreed to build this framework cooperatively
 - Transportation layer is high priority
 NGTN Project Results CCOG Presentation

7



CGDI Standards

- International Participation:
 - ▶ ISO Technical Committee 211 (Geomatics Standards)
 - **OpenGIS Consortium**
 - ISO TC 204 (Transport Information and Control Systems)
- Objectives:
 - participate in evolving world standards
 - help Canadians anticipate, adopt, and use standards

NGTN Project Results - CCOG Presentation



Framework Data Objectives

- To provide national coverage of commonly used datasets
- To allow Canadians to use data that are compatible
- To provide data tools and services to work with the data

Geoplan



Building Framework Data

- Leadership involves stakeholders who create, maintain, supply or distribute geospatial data
- Being developed in partnership to ensure national coverage in varying levels of detail for many user applications
- Willingness among stakeholders to

Network Data Study Workplan

- Part 1: Data Model Synthesis
 - ▶ Telephone survey and on-site interviews
 - Data model review
 - ▶ Phase 1 report (Feb. 26, 2001)
- Part 2: Confirmation of Approach
 - National workshop (March 7, 2001)
- Part 3: Develop Strategy
 - Draft report March 31
 - Final report (mid-April 2001)
 - Final presentation (April 26, 2001)

NGTN Project Results - CCOG Presentation

Geoplan

Rationale for Study

- Ground transportation (and specifically road) network has been clearly identified as a top priority for framework data within the CGDI
 - Initial framework study
 - Benefit-cost study
 - Framework data workshops
- This data can generate significant benefits to both public and private sectors

12

NGTN Project Results - CCOG Presentation

Caveats

- Primary focus on *road* data models
- Study does not provide *detailed* implementation plan and technology architecture
- Core Transportation Architecture Team needed to implement the strategy
- Components are available but will need significant effort to implement

13

NGTN Project Results - CCOG Presentation

Geoplan

Potential Benefits

- Public sector:
 - minimize duplication of effort in data collection
 - maximize data integration / sharing
 - enable high priority applications (E911, asset management, ITS, logistics, etc)
- Private sector:
 - **Business Geographics**
 - value added information products
 - applications (ITS, logistics, vehicle navigation, etc)

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NGTN Project Results - CCOG Presentation

Stakeholder Interviews

- Initial round completed by December 19, 2000
- On-site interviews in Ottawa and each province to get stakeholder feedback
- Telephone interviews conducted to gain additional input
- Topics:
 - network data holdings and models
 - b data sharing agreements
 - implementation issues and concerns

NGTN Project Results - CCOG Presentation

Geoplan

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Main Observations

- Highly public sector oriented, need more feedback from private sector
- Provincial interest:
 - for applications support (e.g., ambulance dispatch: NB, NS)
 - coordinated initiatives: ON, NS, BC
 - ORN is early form of model approach
- Updated Road Network (URN) common geometry by fall 2003

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NGTN Project Results - CCOG Presentation

Main Observations (cont'd)

- IP issues remain single largest impediment
- Need for currency will require new approach to database maintenance strategies: feature based
- Private sector concerns regarding undermining of existing products
- Possible impacts on agency business cycles

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NGTN Project Results - CCOG Presentation

Geoplan

Implementation Issues

- Industry concerns: revenue loss / competition
- Metadata as critical component of data maintenance architecture
- Areas of technical focus (model):
 - Linear referencing / dynamic segmentation
 - Routing
 - Civic address coding

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NGTN Project Results - CCOG Presentation

Implementation Issues (cont'd)

- Disconnect between data suppliers and users regarding importance of some standards and specifications
- Agencies who were unwilling to share data stated concerns re:
 - proprietary data products
 - need for more specific information
- Data model and standards must support feature based update

NGTN Project Results - CCOG Presentation

Geoplan

Private Sector Perspective

- Private sector is not likely to be a willing contributor of data under the current conditions
- Would provide only data that is not considered to be part of their "core" intellectual property
- Private sector is likely to be interested in licensing available attribute data from a national transportation road network database
 provided that the data is current and accurate

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NGTN Project Results - CCOG Presentation

Private Sector (cont'd)

Policies must:

- Establish a level playing field promote competition without threatening competitive positions of private sector firms.
- Respect the importance of protecting the IP and ownership of private sector data contributions. Private sector data incorporated into public sector data holdings, then potentially made available for "license" to competition is unacceptable.

NGTN Project Results - CC

Geoplan

Approach to NGTN Model

- Not within project scope to develop entirely new data model for NGTN
- Review a number of existing models against a standard set of evaluation criteria
- Models reviewed *not* an exhaustive list:
 - **UNETRANS** proprietary
 - NCHRP 20-27(3) not available
 - others ...
- Develop implementation options and recommendations based on results

NGTN Project Results - CCOG Presentation

Geoplan

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Data Model Issues

- Network segmentation
- Segment identifiers
- Road name identifiers
- LRS
- Feature content
- Topological constructs
- Attribution
- Metadata
- ISO / TC204 ITS location referencing
- Coordinate systems
- Other issues

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NGTN Project Results - CCOG Presentation

Geoplan

Candidate Data Models / Standards

- GDF/ISO TC204
- DIGEST TLD
- FGDC Framework Transportation Identification Standard
- NCHRP 20-27
- National Geographic Database (NGD)
- NR Can Updated Road Network (URN)
- Ontario Road Network (ORN)
- Transportation Association of Canada (TAC) GIS-T Data Standards

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NGTN Project Results - CCOG Presentatio

Evaluation Results

- No model satisfied all criteria
- While focus on *road* data, models are extendable for rail use
- A gap between traditional data gatherers / users and vertical market users (ITS)
- Recent active (and competitive) interest in data model development
 - no current consensus on best practice
- Private sector developments may be key

NGTN Project Results - CCOG Presentation

Geoplai

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Evaluation Summary

- Deficiencies in all models
- GDF may represent overall "best fit"
 - issue regarding LRS capability
 - this area requires further investigation
- Further research needed
 - ▶ GDF 4.0 still in draft
 - NCHRP 20-27(3) report not yet available

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NGTN Project Results - CCOG Presentation

NGTN Implementation Alternatives

- At least two possible courses of action:
 - Adopt a strategy that delivers short term results with a sub-optimal model and work toward longer term vision implementation
 - Commit to delivery of an integrated model based upon latest GDF view and aggressively pursue implementation
- Second approach preferred:
 - Canada has expertise, knowledge and funding (through GeoConnections) to deliver
 - What's needed: 1) Vision 2) Commitment

NGTN Project Results - CCOG Presentatio

Geoplar

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Implementation Principles 1

- Build upon existing initiatives
- Adopt a phased approach with clear milestones
- Converge quickly on national attribute coding standards within a core attribute data model
- Ensure that the needs of agencies requiring the integration of linear network data are taken into account

NGTN Project Resul

Geoplan

2

Implementation Principles 2

- Use public / private partnerships
- Implement NGTN road network spatial database and its associated core attributes as the transportation framework layer of the CGDI and made available at minimum / low cost with no copyright or licensing restrictions
- Make an extended set of attributes available for a price

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NGTN Project Results - CCOG Presentatio

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Implementation Principles 3

- Establish a common set of agreed information components based on a combination of profiles of international standards
- Provide an enhanced metamodel and services that would facilitate exchange of information between parties
- Implement services within CGDI to support the use of several models so all jurisdictions can participate

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NGTN Project Results - CCOG Presentatio

Key Recommendation

Specifically, a move to a fully integrated NGDN data model is recommended. This model should be based upon emerging industry standards for transportation data models, and the GDF transportation data model standard. Further research is needed in support of this recommendation.

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NGTN Project Results - CCOG Presentation

Geoplan

Project Status (April 2001)

- Draft final report submitted
- Presentation to CCOG made
- Final report in mid-April
- Final presentation to Project Steering Committee and GeoConnections Management Board on April 26

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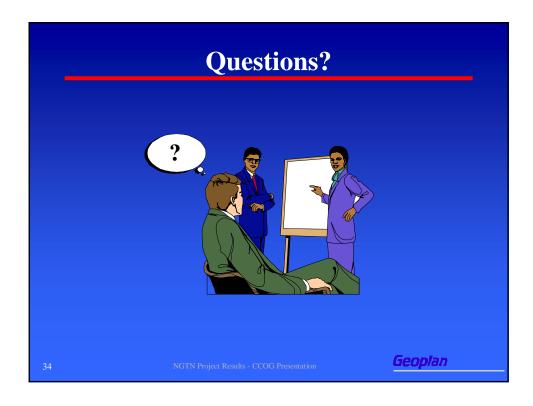
NGTN Project Results - CCOG Presentation

Summary

- Common core of freely available data
- Common network segmentation
- Migration toward international standards

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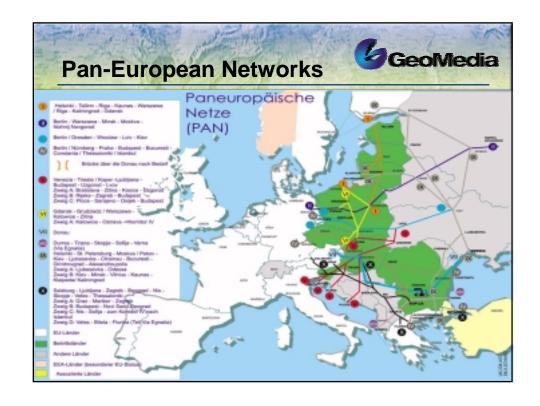
IGTN Project Results - CCOG Presentation

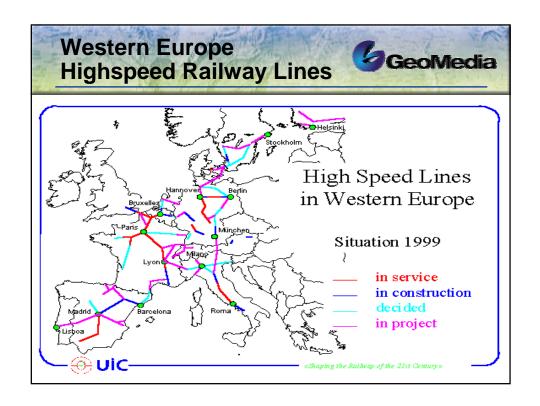


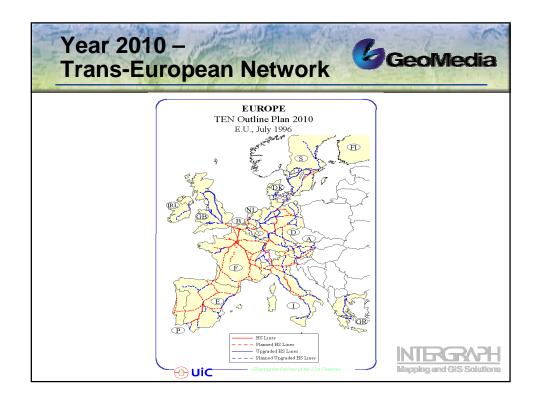


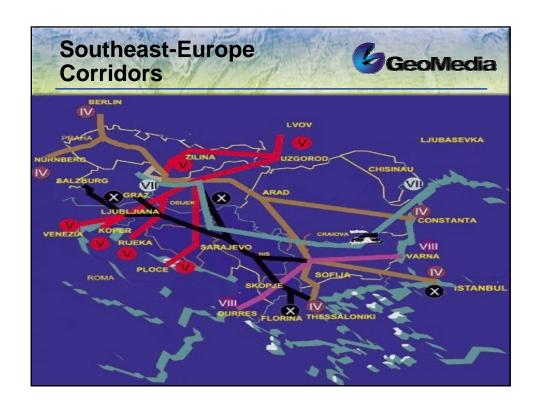


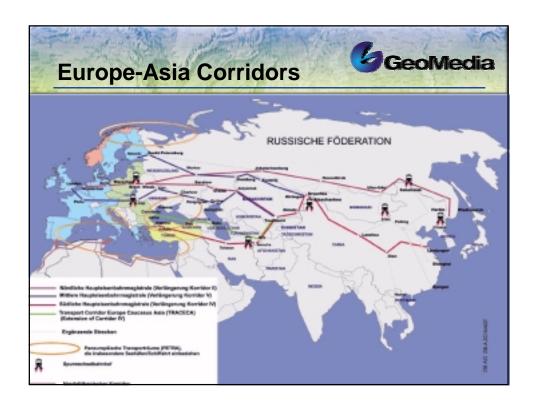


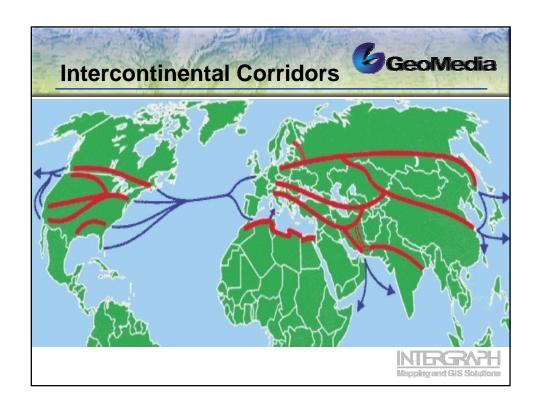


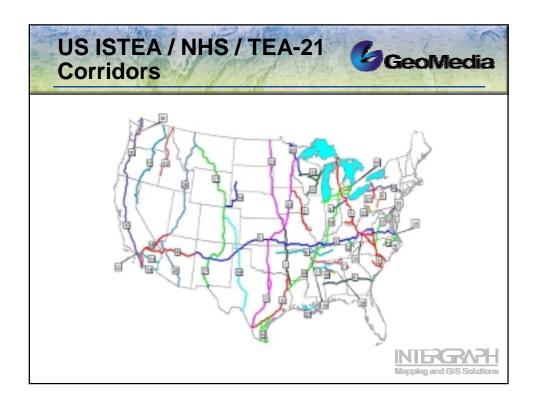


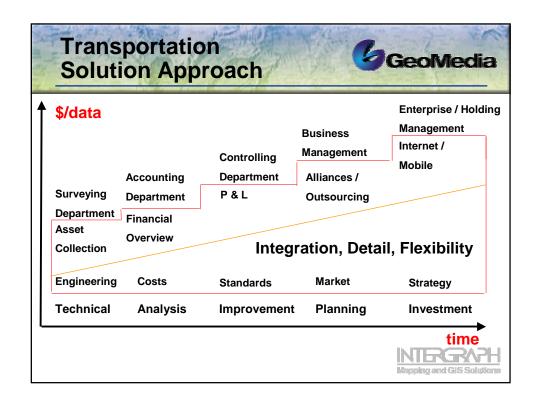


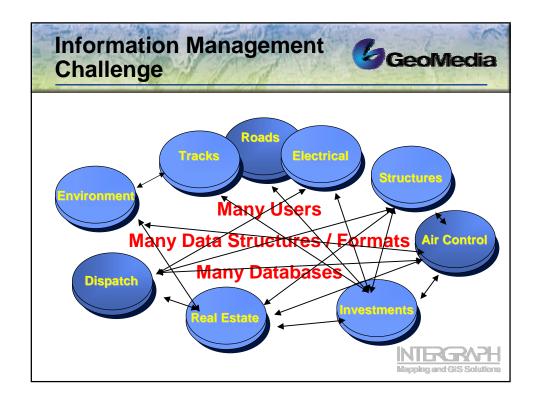


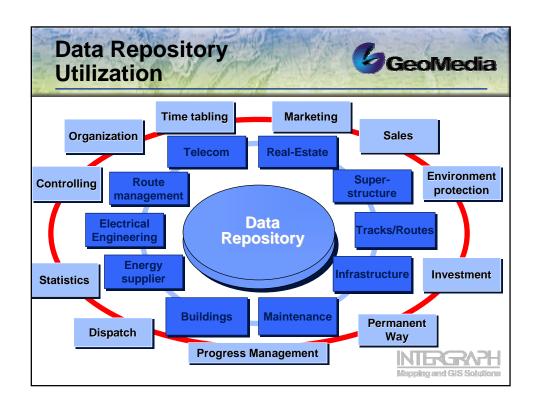


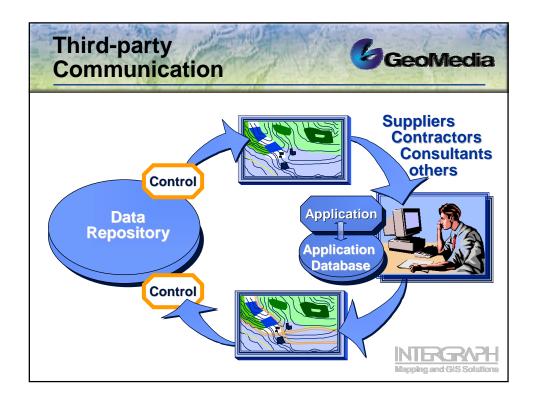


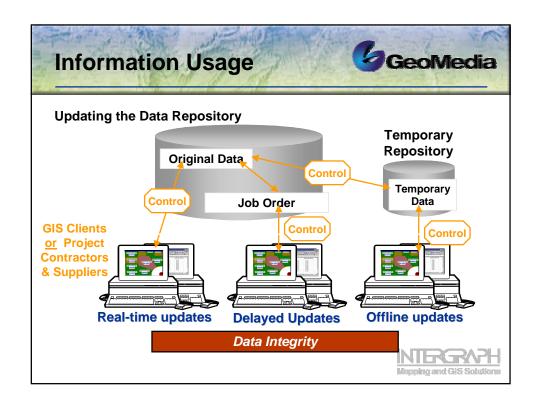


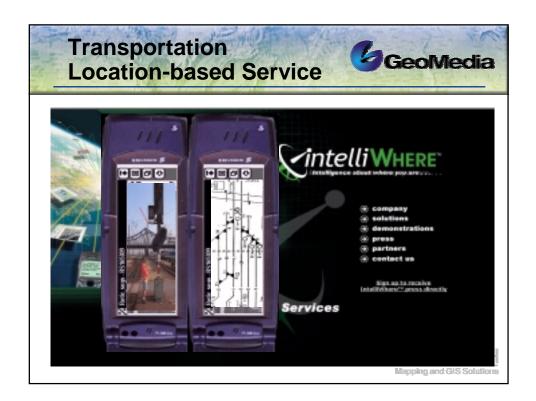
















Case 1 – German Rail: (DB AG)



> DB AG

- 40,000 km of track
- over 200,000 employees
- major re-organization
- largest transportation company in Europe







Case 3 – Croatian Road Administration GeoMedia

Croatian Road Administration

Responsible for the

 $management, \ administration \ and \ operation$

of the

Croatian state roads

"Pavement and Bridge Management Information System"

Initiated by the

Government of the Republic of Croatia

based on a loan from the

International Bank for Reconstruction and Development (World Bank)



Case 3 – Croatian Road Administration GeoMedia

Goals

Optimal management and operation of the Croatian road network

for decongestion on networks, optimization of traffic flow and major enhancements of security

Project stages

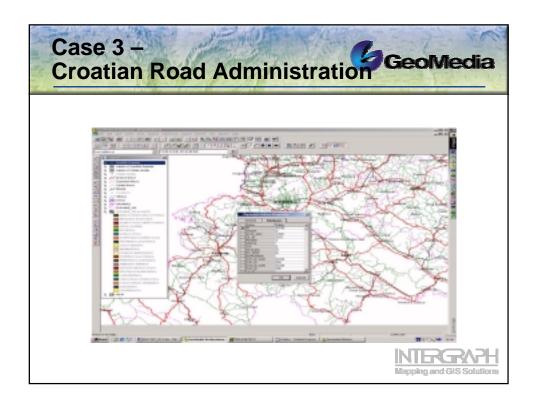
Current stage -> GIS (GeoMedia) based technology
Visualization of spatially referenced road network data
Provision of decision support information to all levels of
management

Future stage --> Overall Road Industry Solution serving as a major reference within the total Southeastern Europe transportation area











Case 4 – Cas

Romanian Railways

- Fourth largest railway network in Europe in terms of total line length and traffic volume
- Covers entire Romanian territory (14,220 km of track)
- Manages freight and passenger rail traffic and administers the national railway infrastructure
- Ensures continuity of the European transportation system and provides efficient connections with other transport systems (road, river and sea)

as well as with Eastern Europe and the Middle East

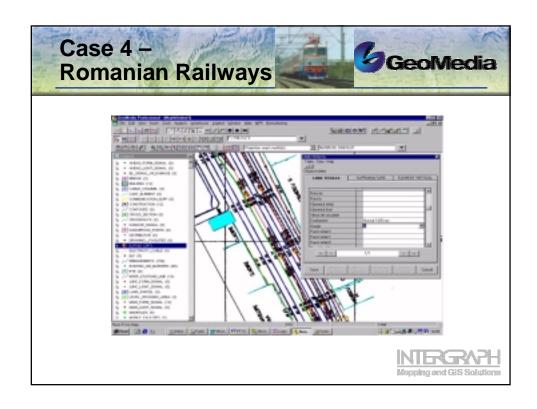


Case 4 – GeoMedia

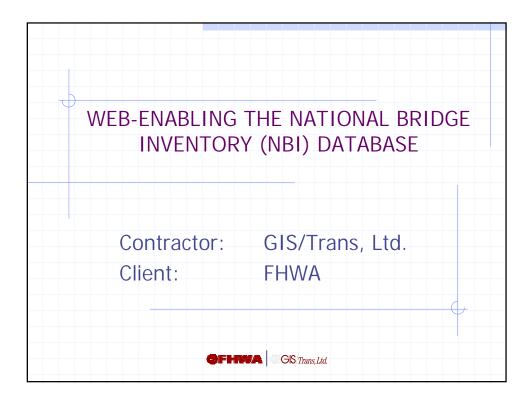
- Responsibility
 - "CFR" S.A. (Compania Nationala de Cai Ferate)
 - = Organization responsible for infrastructure and information technology (IT) at Romanian Railways
- Infrastructure Asset Management System
 - GeoRail (GeoMedia based Industry Rail Solution) integrated with maintenance system











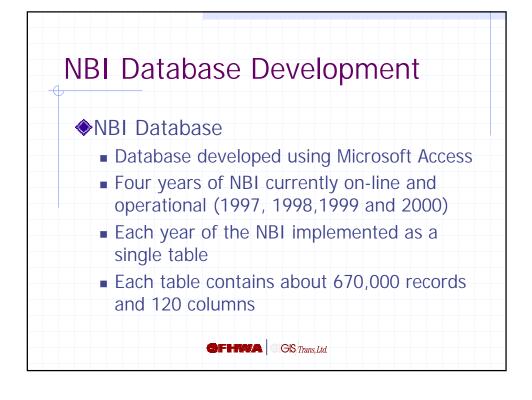
Project Objectives

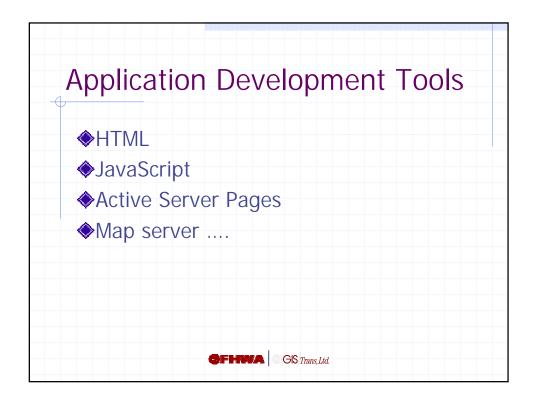
- Obtain copy of all years of NBI data and place it on-line
- Develop functionality that will enable
 - Downloading NBI data
 - Analyzing information from NBI
 - Spatial display of bridge information
 - Display charts of bridge information
 - Produce standard reports
- ◆ Integrate Web Geographic Information System Tools

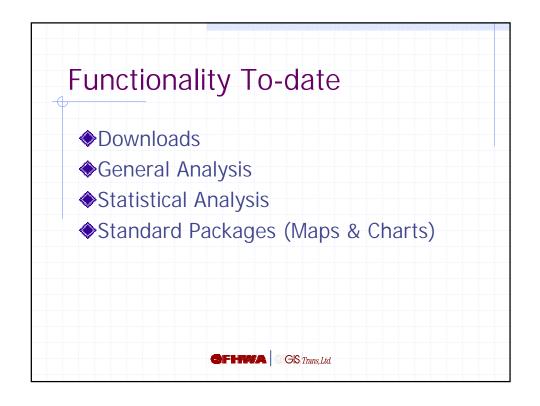




Motivation Better understanding of bridges Number, Materials, Owners, Usage Deterioration patterns Help prioritize bridge management research by identifying the most important problems



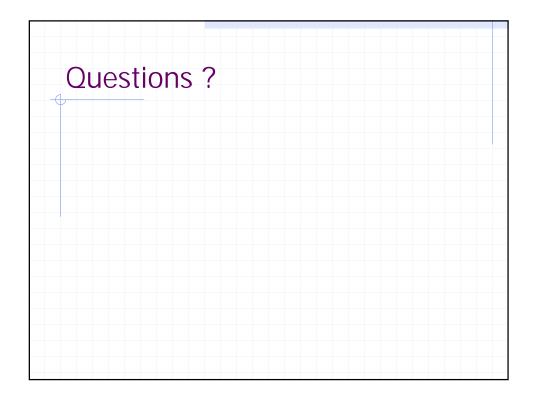




Future Activities ◆Migration of database from MS-Access to Oracle ◆Fully develop the map server functionality to facilitate dynamic mapping



What's next Place all the NBI data over the past 25 years on-line. Develop an integrated dynamic data and mapping tools.





Iowa DOT Image Catalog

Bill Schuman
GIS Coordinator
Iowa Department of Transportation

Todd Noah
Assistant GIS Coordinator
Iowa Department of Transportation

Presentation Outline

- Problem addressed
- Desired data
- Technologies
- Project needs
- Application
- Benefits
- Future
- Summary\Conclusion



Problems Addressed

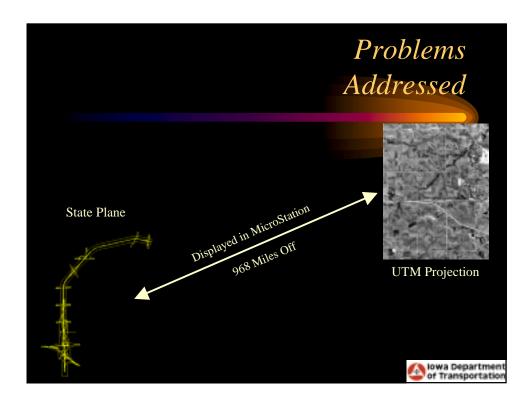
- Data Storage /Format
 - Original DOQQ's GeoTiff's size
 - 45-50MB per image
 - Disk space
 - 300GB of digital imagery (Uncompressed)
 - LAN traffic
- Solution
 - Compress images



Problems Addressed

- Projection/Georeferencing
 - Original DOQQ's UTM\NAD83
 - MicroStation design files in State Plane\NAD83
 - No image viewing software on MicroStation
- Solution
 - Transform USGS DOQQ's from UTM\NAD83 to Iowa State Plane North and South





Problems Addressed Access to data Many servers and directories throughout DOT One stop geo-imagery shopping Satellite images Aerial photos (DOQQs, county and regional flown) Digital Raster Graphs (DRGs) Solution Map interface needed to show availability and location on LAN of all images

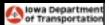
Data Desired

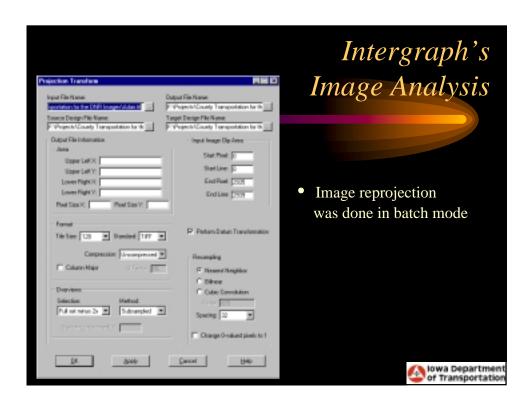
- Data Needed
 - Digital Ortho Quarter Quads (DOQQ's)
 - Digital Raster Graphs (DRG's)
 - Satellite imagery
 - County aerial flights
 - Iowa DOT aerial flights
 - Iowa DOT centerline data
 - County borders
 - Rivers and other needed reference features

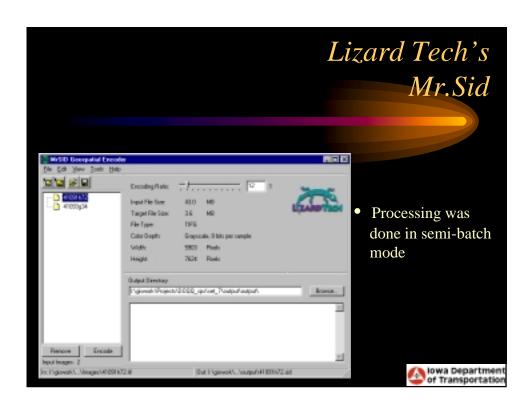


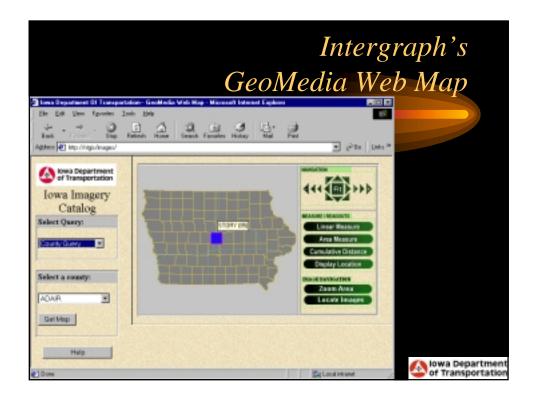
Technologies Used

- Software capable of reprojecting images
 - Intergraph's Image Analyst
- Image compression software
 - Lizard Tech's Mr.Sid
- Web Environment
 - IIS technology
 - GeoMedia Web Map
 - Browser plug-in











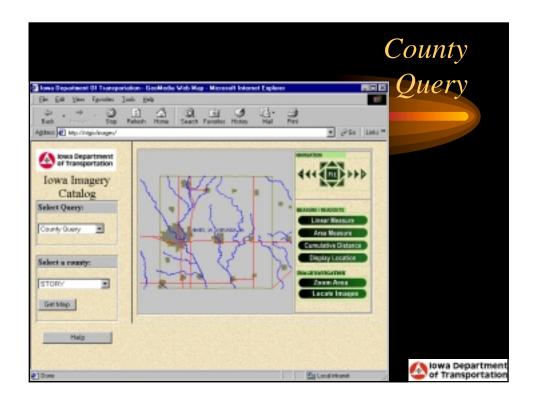
Project Scope

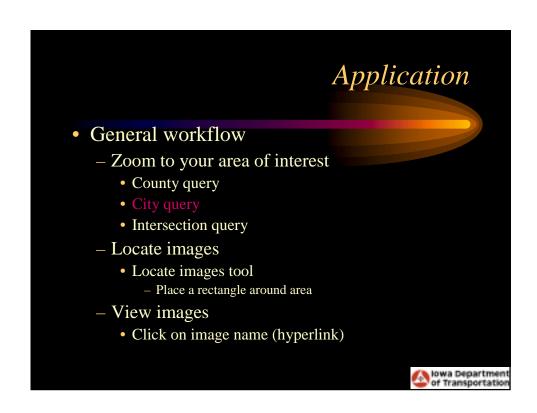
- Contract with Intergraph
 - Develop the initial web page
 - Train Iowa DOT staff to maintain web page
- Internal Staff
 - Reproject images from UTM to State Plane
 - Compress all images
- Maintenance
 - Trained staff maintain web page
 - Add additional images and functionality as needed.

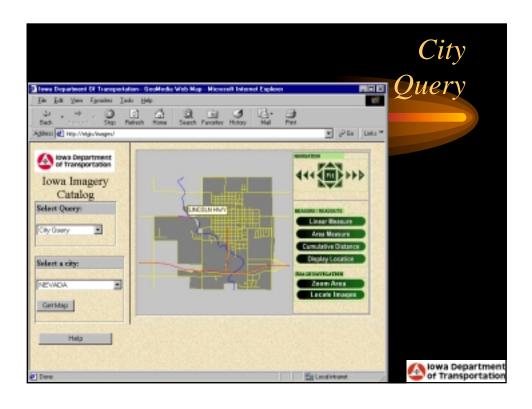
Application

- General Workflow
 - Zoom to your area of interest
 - County Query
 - City Query
 - Intersection Query
 - Locate Images
 - Locate Images Tool
 - Place a rectangle around area
 - View Images
 - Click on Image Name (hyperlink)

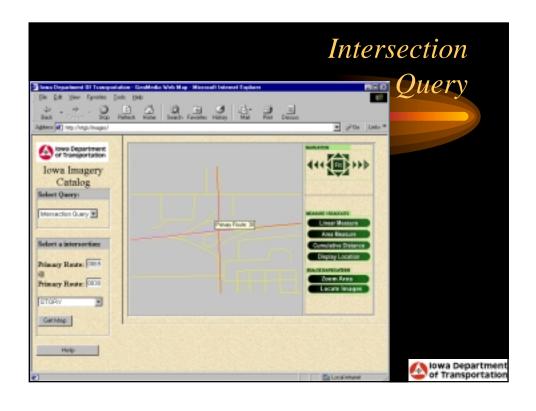


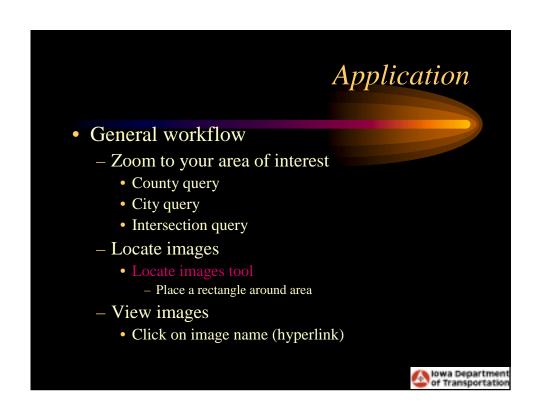


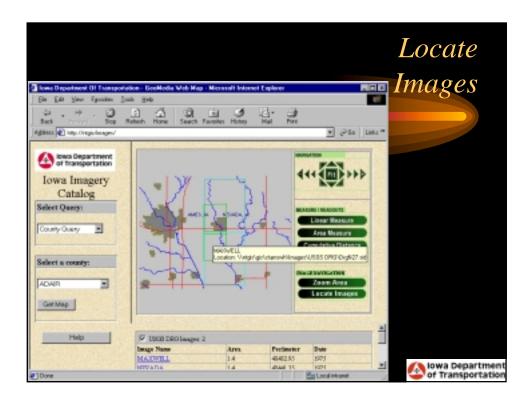




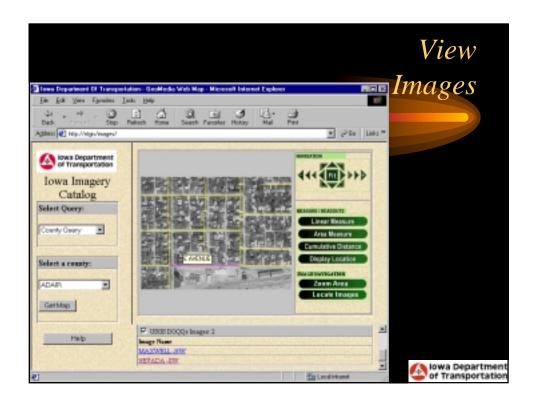


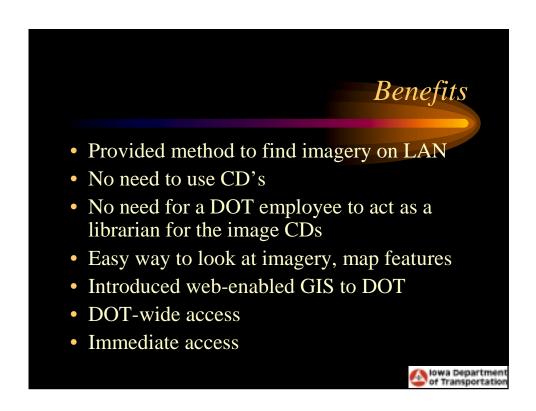






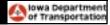






Future

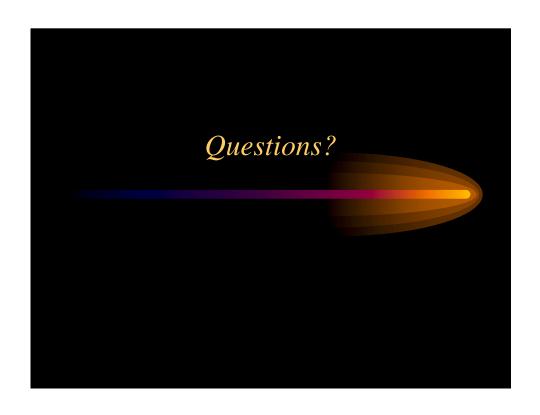
- Additional images added to the application
- Better metadata for images
- Simplify image query component
- More web page development
 - HARN control point web page
 - Traffic volume web page
 - Asset management pages



Summary Conclusion

- Project was a success
 - Provided more data access
 - Eliminated human intervention in the access
- Provided a valuable tool
 - Many people are accessing the page
 - No special desktop software needed to view imagery
- Allowed Iowa DOT employees to see other uses of web-enabled GIS





GIS AS A MONITORING AND MEASUREMENT TOOL IN TRANSPORTATION OPERATIONS



CLEAN CITY INITIATIVE

- A MEASUREMENT TOOL FOR ASSESSING THE PROGRESS OF THE MAYORS CLEAN CITY INITIATIVE
- A PERFORMANCE TOOL FOR KEEPING DEPARTMENT HEADS ON TRACK WITH THE MAYORS SCORE CARD
- AN ACCOUNTABILITY TOOL FOR DISTRICT RESIDENTS TO MEASURE THE MAYORS SERVICE DELIVERY



CAPITAL IMPROVEMENT PROGRAM

- PAVEMENT CONDITIONS BY DIFFERENT COLOR
- BUDGETED LOCATIONS BY DIFFERENT WORKTYPE
- FEDERAL AID RESURFACING
- RECONSTRUCTION
- LOCAL STREET IMPROVEMENTS



of Division of Transportation

SNOW

- INCREASE ROUTING EFFICIENCY
- IMPROVE OPERATIONAL PLANNING AND EXECUTION
- IMPROVE COMMUNICATION AND INFORMATION SHARING WITH THE EMERGENCY MANAGEMENT AGENCY (EMA)
- IMPROVE RESOLUTION OF CITIZEN COMPLAINTS

DIFFERENT MAPS

- FUNCTIONAL CLASSIFICATION
- HPMS (HIGHWAY PERFORMANCE MEASURING SYSTEM)
- NATIONAL HIGHWAY SYSTEM



UTILITY CUTS

- IDENTIFY UTILITY AND TELECOMMUNICATION COMPANIES USE OF THE DISTRICT OF COLUMBIA'S RIGHT-OF-WAY
- ENHANCE AND EXPEDITE THE PERMITTING PROCESS
- SHOW SUSPENDED STREET LOCATIONS
- ENSURE THAT FREQUENT UPDATES TO THE SUSPENDED STREETS ARE READILY AVAILABLE TO ALL INTERESTED ENTITIES
- IMPROVE COORDINATION BETWEEN UTILITY
 AND TELECOMMUNICATION COMPANIES IN
 TERMS OF COLOCATION AND PERMITION OPPORTUNITIES

TRAFFIC

- STUDY TRAFFIC ACCIDENTS WITHIN THE DISTRICT OF COLUMBIA
- OVERLAY ANALYSIS TO EXAMINE CAUSAL FACTORS
- MODEL TRAFFIC FLOW
- IMPROVE TRAFFIC LIGHT SEQUENCING IN THE DISTRICT
- IMPROVE TRAFFIC STUDIES



INTRODUCTION OF NEXT SPEAKER

• EMMANUEL ONWUKWE OF GEO-IMAGING INC. GIS CONSULTANT TO DPW/DDOT



A spatial framework for modeling hazards to transportation networks

Thomas Cova, Jan Husdal and Harvey Miller Center for Natural & Technological Hazards Department of Geography University of Utah

National Consortia on Remote Sensing in Transportation (NCRST): Disaster Assessment Safety and Hazards (DASH) http://www.trans-dash.org

Outline

- Research motivation and objectives
- Background: hazards to transportation systems
- A conceptual framework for modeling hazards to transportation systems
- Case study: identifying potential avalanche paths in Little Cottonwood Canyon, Utah
- Future research
- Conclusions

Research Motivation & Objectives

Research motivation

Avalanches, landslides, debris flows, earthquakes, fires, floods, fog, wind and many other environmental hazards routinely damage and/or disrupt transportation systems. The monitoring, assessment, prediction, and mitigation of these events by transportation agencies is very thorough for some hazards in select areas but nonexistent in others.

Research objective:

Develop a method for assessing transportation lifeline hazard vulnerability that can be *uniformly* applied. The method should be general enough to apply to a variety of hazards.

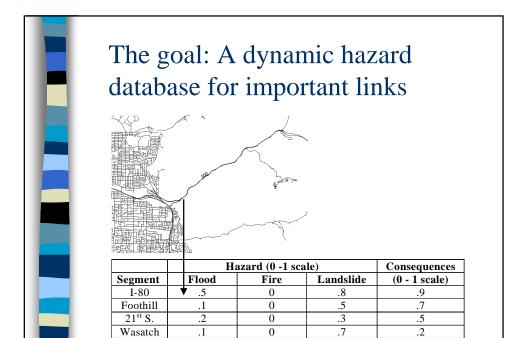
Hazards to transportation systems

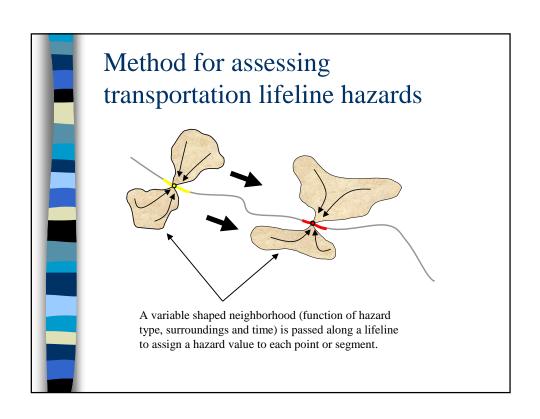
Hazard assessment (pre impact)

- Landslide hazard to road, rail, and pipeline (Turner & Schuster, 1996).
- Avalanche handbook (McClung & Schaerer, 1993).
- Rockfall on highways (Bunch, et al., 1997).
- Wind effects on roads (Perry & Symons, 1994).
- Dam failure modeling (USBR, 2000).

Recovery analysis (post impact)

- Seismic loss to highway systems (Werner, 1997).
- Road project reconstruction after earthquake (Bowman, 1995).
- Earthquake effects on major ports. (Chang, 2000).

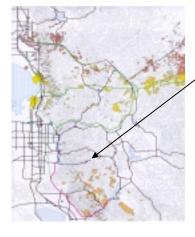




Central questions

- How can the "hazard neighborhood" at a location on a road be computed (landslide, avalanche, debris flow, flood, etc.)?
- What are the relevant thematic layers for computing the hazard to a network within this neighborhood?
- How can a hazard score be developed for a particular length of road?
- What information is available from remote sensing inputs?

Avalanche hazard case study: Little Cottonwood Canyon





- Famous canyon in avalanche science.
- 50 year digital record of past slides.
- Canyon road elevation: 5000-9000 ft.
- 30-40 feet of very dry snow per year.
- "One of the highest avalanche risks in the world (Glasier, 2001)."



(Photo by Terry Howard at www.avalanche.org.)



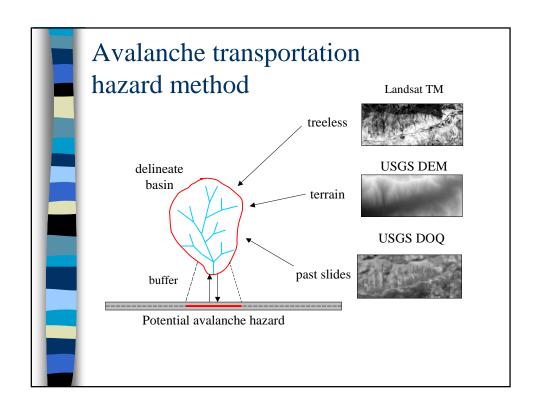
Avalanche path identification versus forecasting

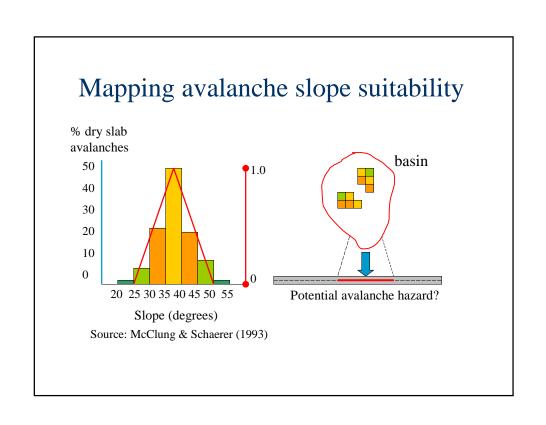
Identifying potential avalanche paths

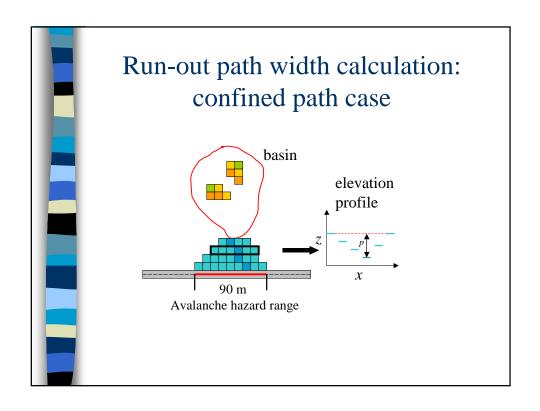
- A search for suitable avalanche environmental preconditions.
- Potential slide paths are the "answer."
- Based on analysis of terrain, vegetation, seasonal snow, wind, and run out zone features.

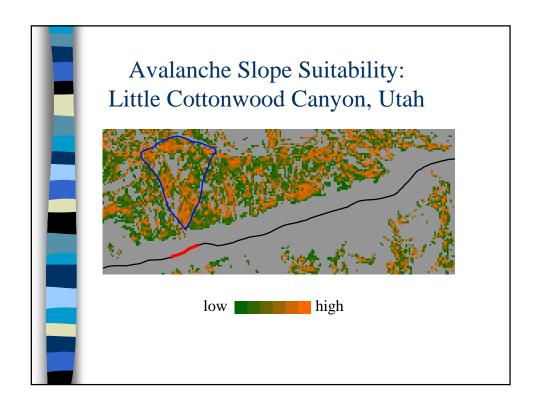
Avalanche forecasting

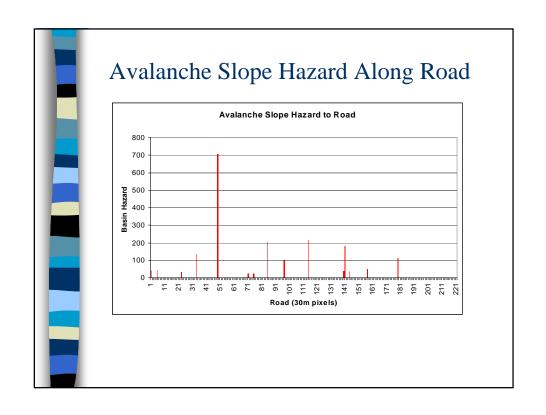
- Analyzing current and future snow stability (Resistance to failure over the forces acting on the failure).
- Slide paths are generally known and well delimited.
- Snow pits are a common field data collection method.

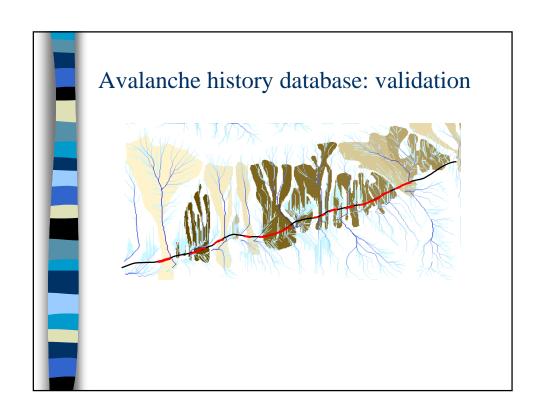










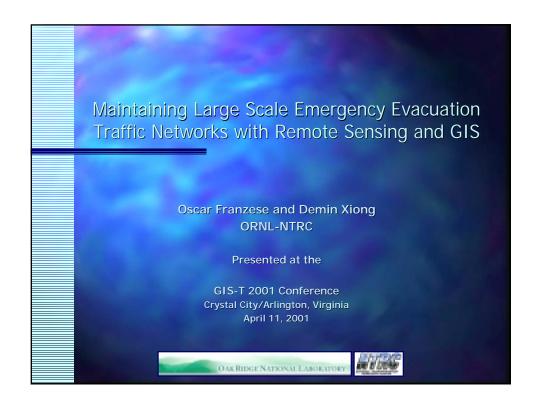


Future Research/Development

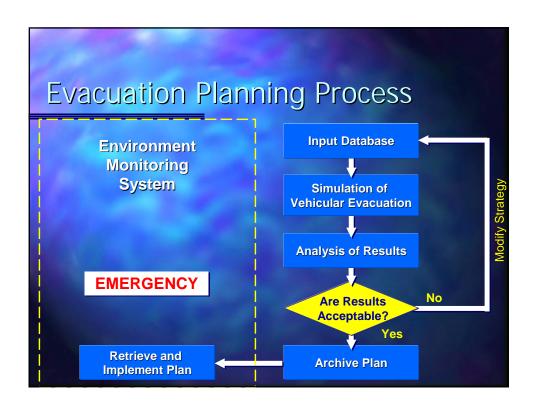
- Avalanche modeling on roads with little or no record.
- Application to other transportation network hazards: landslides, debris flows, rock fall, flooding, etc.
- Modeling and assessing the consequences of hazardous events.
- Incorporating real-time inputs (e.g. snow accumulation).
- Including traffic flow data in the calculation of *risk*.
- Toward operational practice (NCRST)!

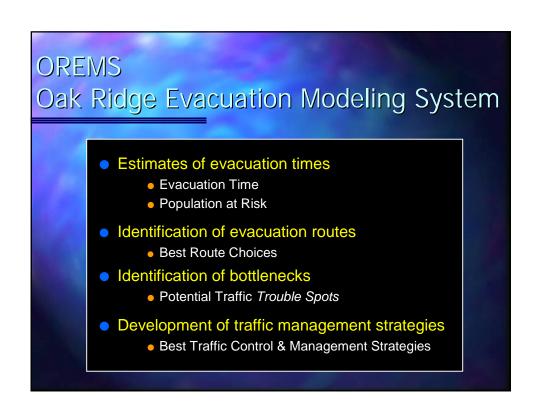
Conclusion

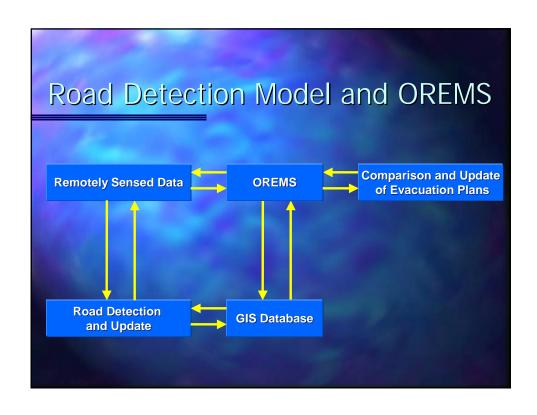
- A preliminary, general method for modeling (primarily geomorphic) hazards to transportation systems has been developed.
- The method is a based on passing a variable-shaped neighborhood along a transportation route and calculating the potential hazard at various points.
- An initial application within the context of avalanche hazard has been performed in Alta, Utah, but much more development and testing remains to be done to put this into operational practice.

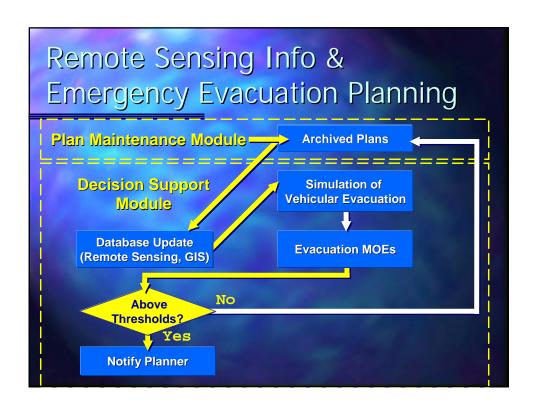


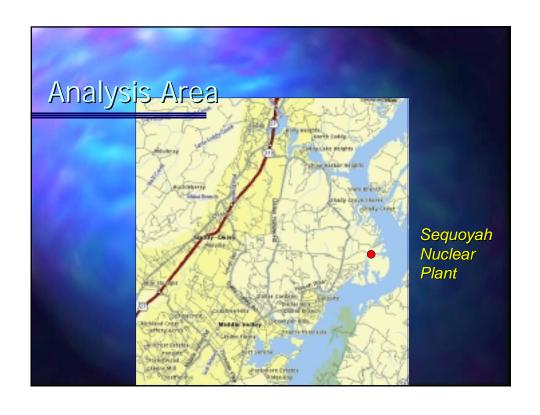


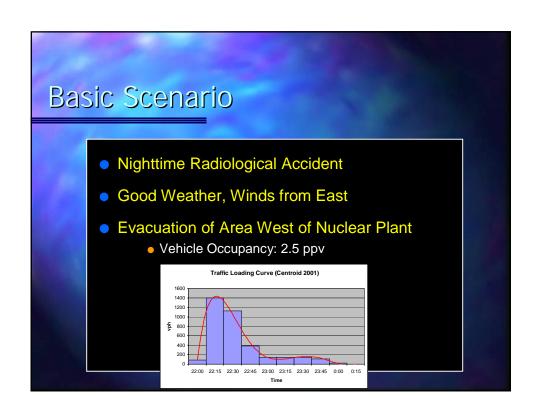




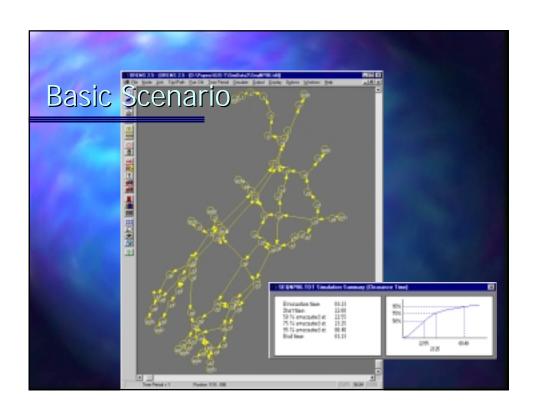






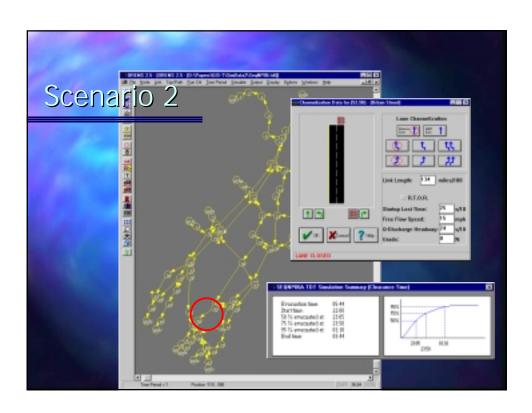






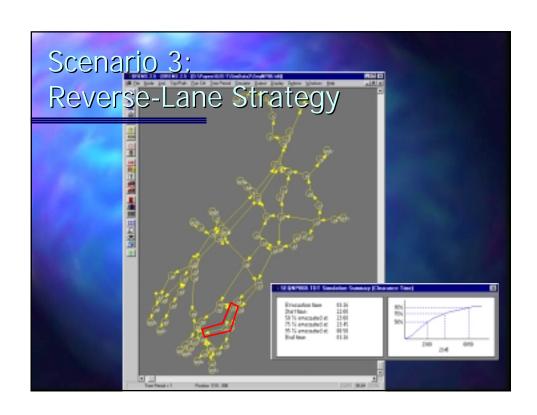
Scenario 2: Imperfect Network Information

- Radiological Accident
- Clear Night, Winds from the East
- Road Capacity Reduction on Arterial
 - Lane 1 Closed Due to Construction
 - Lane 2 Reduced Speeds Because of Lateral Obstructions
- Emergency Evacuation Planners Unaware of Road Capacity Reduction



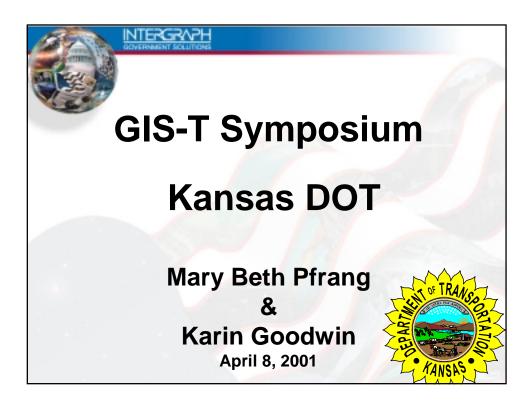
Scenario 3: Automated Network Info Updates

- Radiological Accident
- Clear Night, Winds from the East
- Road Capacity Reduction on Arterial
 - Lane 1 Closed Due to Construction
 - Lane 2 Reduced Speeds Because of Lateral Obstructions
- Emergency Evacuation Planners Notified by Plan Maintenance Module of Surpassed Threshold



Conclusions

- Emergency Evacuation Models
 - Traffic Network Information
 - Demographic Information
- Maintenance of Information is Critical
 - Emergency Plans are Costly to Develop, but Worthless if Information is not Current
- Remote Sensing Information Offers a Solution
- Future Developments:
 - Improve Road Extraction and Attribution Algorithms
 - Real-Time Implementation





INTERGRAPH

How to distribute Safety Information?

Public needs timely information for safe travel

- KDOT needs an easy and cost-effective mechanism to distribute information rapidly to the public
- > The Web
- Critical road condition information must be displayed – such as weather, accidents, constructions, maintenance projects and detours
- > GIS



KDOT he

KDOT helps solve Public Safety issues

- Implementing public access web-based systems that report real-time current conditions
- Multiple Phases
 - 1. Road Condition Reporting System
 - 2. Construction Detour Reporting System
 - 3. Other systems in the future....



GOVERNMENT SOLUTIONS

Road Condition Reporting System

Kansas Department Of Transportation
Bureau of Transportation Planning



INTERGRAPH GOVERNMENT SOLUTIONS

Road Condition Reporting System

- The webpage: http://Kanroad.org
- Web-based internal and public application
- Real time map of <u>actual</u> road conditions
- 1st KDOT Interactive website at KDOT
- 1st KDOT GIS website

KDOT Personnel Included

- Bureau of Transportation Planning
 - Project Management
 - Maintenance of solution
- Bureau of Computer Services
 - Internet/Intranet team
 - Oracle Database team
 - Network team
- Office of Transportation Information
 - Disseminate info to the Public
- Bureau of Construction and Maintenance
 - Data Entry



INTERGRAPH SOVERNMENT SOLUTIONS

Other State Agencies and Systems Involved

- Kansas Turnpike Authority
- Kansas Highway Patrol
- CJIS Criminal Justice Information System

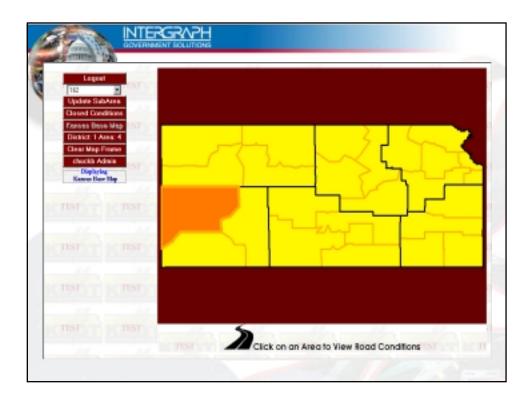
Improves reliability and accuracy of data!

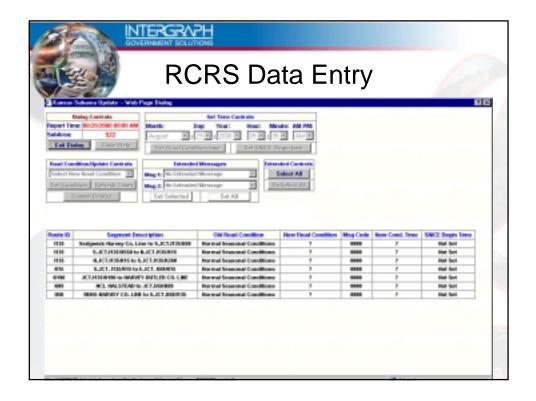


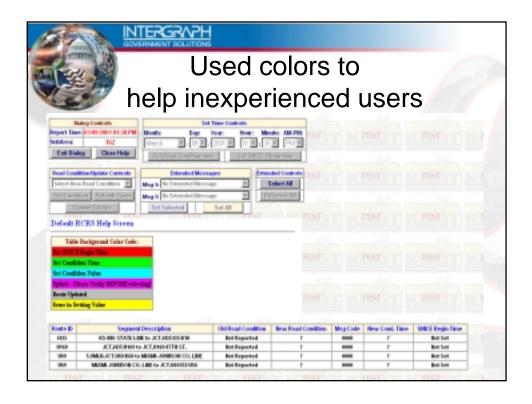
INTERGRAPH GOVERNMENT SOLUTIONS

Intranet Functionality

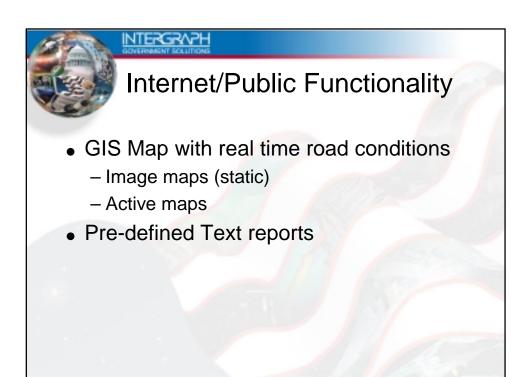
- Data Entry
 - Road Conditions to create a real-time map for public viewing
- Data Collection
 - SNICE Performance Data
 - Transfer of SNICE Data to the Bureau of Construction and Maintenance

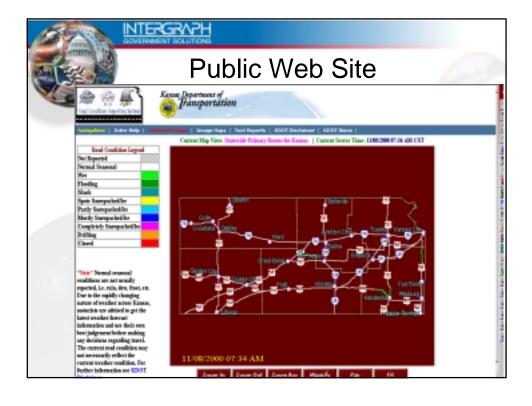


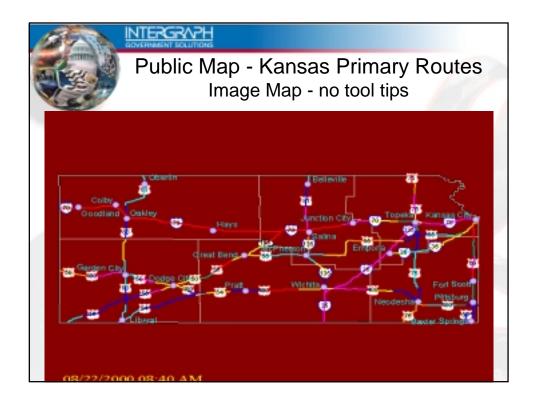


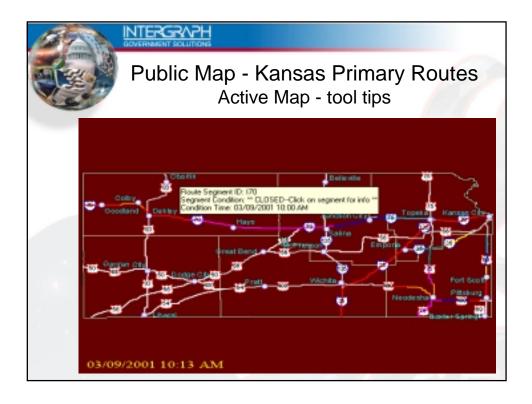


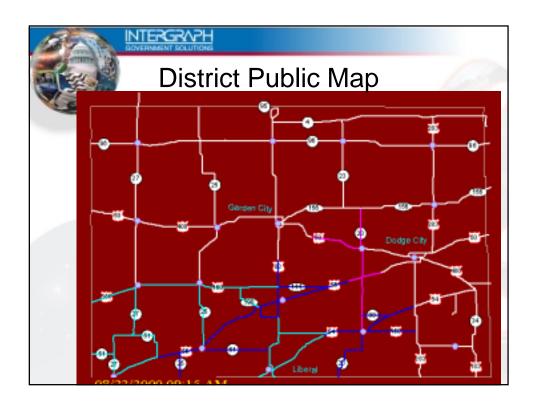


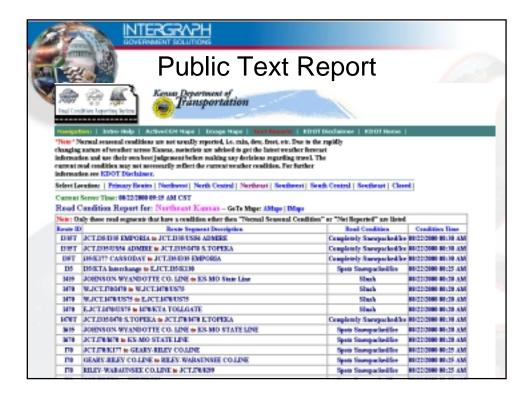


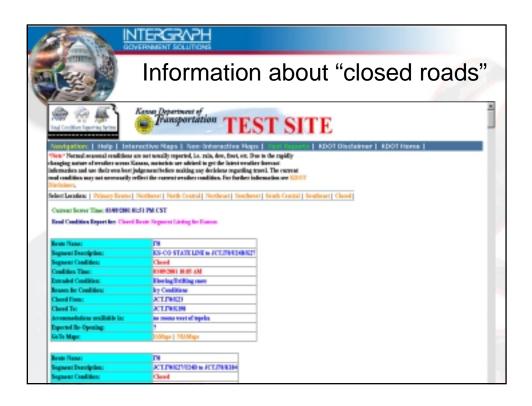


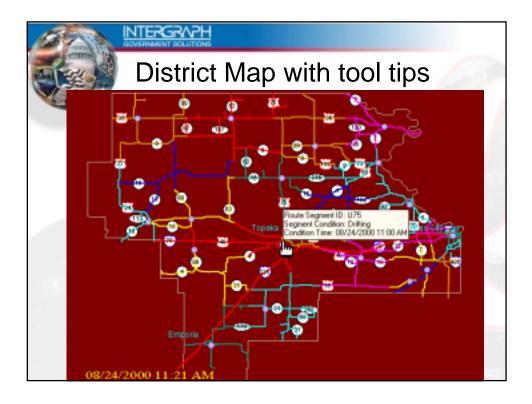


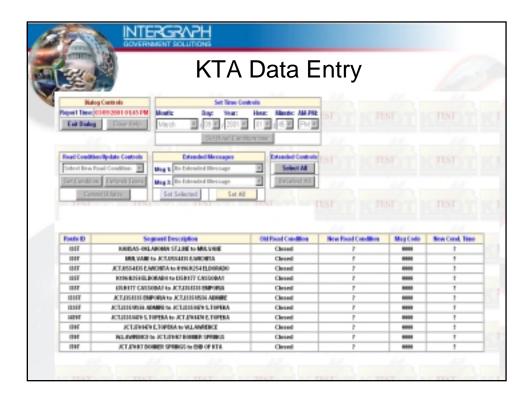


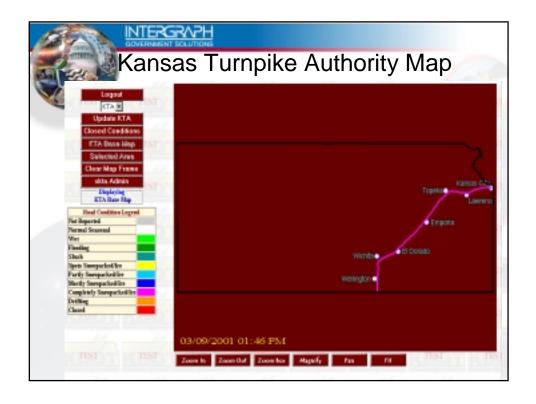














INTERGRAPH GOVERNMENT SOLUTIONS

Benefits of RCRS

Some quotes from the Public:

"Your map listing is a great asset to the citizens of Kansas and I thank you for it."

"I just signed on to your web page for the first time and you're to be commended for an excellent site. I will use it often for road conditions..."

"I have recently discovered and used the new KDOT highway conditions map and it is great. Last week I wanted to monitor the highways so I could inform my daughter who was planning on driving home ... when we had all the snow. Use of this web site provided me helpful information so I could tell her the best route to take based on highway conditions. Thank you for providing this valuable service."



INTERGRAPH GOVERNMENT SOLUTIONS

KDOT Future Plans

- Develop a campaign to make the public aware of the site
- Continue to work with KHP, CJIS and the Turnpike Authority
- Construction Detour Reporting System
- RCRS Enhancements should merge with CDRS



Construction Detour Reporting System

- Display many new data types to assist the public in safe travel throughout Kansas
 - Construction, Maintenance projects, Detours, Accident information, Lane Restrictions
- Combined system with RCRS to offer year round traveler safety information

